JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA,

FOR THE

PROMOTION OF THE MECHANIC ARTS.

SEPTEMBER, 1860.

CIVIL ENGINEERING.

*Angular Troughs or Pipes, and Angular Bottoms to Drains.** By C. H. G. Thost.

Dissatisfied with the means of conveying the lead-ore from the mines to the stamping mills at Tyndrum Mines, I was led to devote my attention to the possibility of taking advantage of the moving power of water in close drains or pipes.

For this purpose a square pipe or trough was laid down from the entrance of the mine to the low grounds, a distance of 1200 feet, and having an inclination varying from 13 to 20 degrees. But though the water rushed through this pipe with great velocity, it failed to carry the fragments of ore along with it; these choked up the very mouth of the pipe. Having, therefore, failed in carrying out the idea in the square tube, numerous experiments were tried as to whether altering the form of the pipe would enable the object to be effected. The results showed such a superiority of the angular over the flat, curved, or other forms of bottom, that it was determined to try the experiment once more on the large scale with a tube of that form. The square box or pipe which had been laid down from the entrance of the mine to the low grounds was, therefore, as a preliminary turned on its edge, so that its bottom, instead of being flat, represented an angular channel, each side of which was inclined at an angle of 45°.

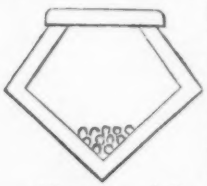
The lead ore, broken to the size of ordinary road metal, was fed by a hopper into the top of the tube; a moderate stream of water was admitted along with it, and the whole ore was passed through the tube

* From the London Civ. Eng. and Arch. Jour., March, 1860.

with an astonishing rapidity, and was delivered at the bottom, no choking taking place at all. Further experiments were made to ascertain the best angle at which the two sides of the base should meet, and it was found that a right angle answered all the purposes better than any other. With such an angle a smaller quantity of water was required to move the pieces of ore in the tubes; and the smallest gravel also, or even the powder of the ore, could be most effectually sent down.

The whole arrangements and general working of the mine were therefore modified so as to permit of this new mode of moving the ore being adopted; and now, not only is the whole ore conveyed by this means, but also all the residuary masses of quartz and other minerals which are cleaned from the lead ores previous to their transmission, are all got rid of by the same means, and deposited with little labor or expense in any desired locality.

To permit of the great wooden trough or pipe which conveys the ore from the mines to the low grounds being easily inspected and repaired, it is now made of the figure represented by the accompanying wood-cut, being in fact just the square box set on one of its angles, and having the upper angle sawn off. A movable cover is fixed securely down by means of cross bands of hoop iron, the ends of these bands being secured by means of iron pins, so that any part of the trough can be readily opened for repairs. The lower angle of the pipe is lined with hoop iron, as without this protection it was found that the angular fragments rapidly wore away the wooden sides. When thus protected, the friction against the sides seems to be much less than might have been anticipated.



Let us now consider the conditions under which the action of the water in moving these masses of ore down such a tube takes place. The resisting power or stability of a block of ore is diminished by the inclination of the tube and by the buoying-up power of the water; and the effectiveness of the action of the stream against the block is secured by the latter not being able to assume any firm position in the channel where it could escape that action. The inclined direction of the flat parts of the tube can offer no such hold to the block as it could obtain in the case of a flat bottomed channel. In the experiments with the flat bottomed tube, when the fragment fell on its flat side, there it stuck; but in the angular tube, from only touching the sides by one or more corners, it was in a position to be easily acted upon by the current.

The cost of this mode of conveyance may now be stated. The original cost of the angular wooden trough at Tyndrum, 1200 feet long, including all fittings, and lining the lower angle with hoop iron, was £70. This trough has been many years in use, and is still quite good; but the annual repairs, chiefly consisting of the renewal of the hoop iron lining, amount to £11 or thereabout. This trough conveys yearly to the low grounds from 1100 to 1200 tons of ore. The ore is supplied to the pipe through the mouth of a hopper; the person attending to

this is able, for the wages of one shilling, to get 40 tons down. This mode of conveyance is therefore the very cheapest yet tried, and as the same means are now applied to the removal of all the debris from the mines, the saving of expense is very considerable. The like system is now employed in the various processes of dressing and washing the ores, the troughs in these cases being open, and many of them are nearly level.

I wish to direct attention to the application of the angular form of bottom to ordinary drains and sewers. It is well known that the great object in giving a particular form to drains or sewers is to prevent the deposit and lodging of mud or sediment of any kind in them. Flat bottomed drains were found to silt up so soon that they have been generally abandoned; and as it was seen that circular pipes did not so easily become obstructed, some approach to the round form has been usually given, thereby incurring considerable expense. Now though sediment of any kind is much less liable to collect in these curved bottom drains, yet they are inferior in this respect to the drain with an angular bottom, as has been fully brought out during the numerous trials I had to make at Tyndrum before hitting on the angular form. And as I there found that even the finest powder of lead ore (which is many times heavier than ordinary mud or sand) was removed from these angular pipes even when at the most moderate inclinations, I am inclined to believe that the general adoption of the angular bottom for all kinds of drains would be a great improvement. In this form of bottom, however small the flow of water may be, it always runs at that part where the sediment can alone settle; and on the occurrence of any greater flow of water, either from heavy rains or occasional flushings, every particle of solid matter would be carried out of the drain.

The adoption, then, of the angular bottom would not only appear to form a more perfect sewer than those at present in use, but from the cheaper character of the bottom a considerable saving in the original outlay would thereby be effected. The bottom angle might be constructed with brick in good cement, or be lined with hard flat stones; but the important point to be attended to is to make the junction at the angle perfectly secure.

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*On the Illumination of Light-houses—The Electric Light.** By M. Faraday, D. C. L., F. R. S., Fullerian Professor of Chemistry, R.I., Foreign Associate of the Academy of Sciences, Paris, &c.

There is no part of my life which more than my connexion with the Trinity House gives me delight. The occupation of nations joined together to guide the mariner over the sea, to all a point of great interest, is infinitely more so to those who are concerned in the operations which they carry into effect, and it certainly has astonished me since I have been connected with the Trinity House to see how beautifully and how wonderfully shines forth amongst nations at large the desire to do good; and you will not regret having come here to-night, if you follow me

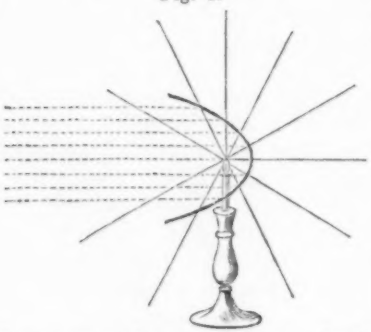
* From the London Chemical News, No. 15.

in the various attempts which have been made to carry out the great object of guiding in safety all people across the dark and dreary waste of waters. It is wonderful to think how eagerly efforts at improvement are made by the various public bodies—the Trinity House in this country, and commissions in France and other nations; and whilst the improvements progress we come to the knowledge of such curious difficulties and such odd modes of getting over those difficulties as are not easy to be conceived. I must ask you this evening to follow me from the simplest possible method of giving a sign by means of a light to persons at a distance, to the modes at which we have arrived in the present day; and to consider the difficulties which arise when carrying out these improvements to a practical result, and the extraordinary care which those who have to judge on these points must take in order to guard against the too hasty adoption of some fancied improvement, thus, as has happened in some few cases, doing harm instead of good.

If I try to make you understand these things partly by old models, and partly by those which we have here, it is only that I may the better be enabled to illustrate that which I look forward to as the higher mode of lighting, by means of the electric lamp and the lime light.

There is nothing more simple than a candle being set down in a cottage window to guide a husband to his home, but when we want to make a similar guide on a large scale, not merely over a river or over a moor, but over large expanses of sea, how can we then make the signal using only a candle? I have shown in this diagram (Fig. 1) what we may imagine to be the rays of a candle or any other source of light emanating from the centre of a sphere in all directions round to infinite distances. After this simple kind of light had been used for some time, it being found to be liable to be obscured by fogs, or distance, or other circumstance, there arose the attempt to make larger lights by means of fires; and after that there was introduced a very important refinement in the mode of dealing with the light, namely, the principle of reflection;—for understand this (which is not known by all, and not known by many who should know it), that when we take a source of light, a single candle, for instance, giving off any quantity of light, we can by no means increase that light; we can make arrangements around and about the light, as you see here, but we can by no means *increase the quantity* of light. The utmost I can do is to *direct* the light which the lamp gives me by taking a certain portion of the rays going off on one side and reflecting them on to the course of the rays which issue in the opposite direction. First of all, let us consider how we may gather in the rays of light which pass off from this candle. You will easily see that if I could take the half rays on the one side and could send them by any con-

Fig. 1.



trivance over to the other side, I should gain an advantage in light on the side to which I directed them. This is effected in a beautiful manner by the parabolic mirror, by means of which I gather all that portion of the rays which are included in it; upwards, downwards, sideways, any where within its sphere of action; they are all picked up and sent forward. You thus see what a beautiful and important invention is that of the parabolic reflector for throwing forward the rays of light.

Before I go further into the subject of reflection let me point out a further mode of dealing with the direction of the light. For instance, here is a candle, and I can employ the principle of *refraction* to bend and direct the rays of light, and if I want to increase the light in any one direction I must either take a reflector or use the principle of refraction. I will place this lens (Fig. 2) in front of the candle and you

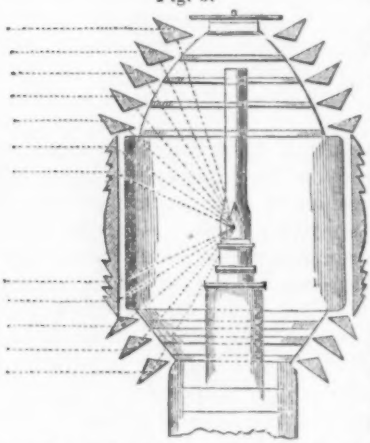
Fig. 2.

will easily see that by its means I can throw on to that sheet of paper a great light, that is to say, that instead of the light being thrown all about, it is *refracted* and concentrated on to that paper; so here I have another means of bending the light and sending it in one direction; and you see above a still better arrangement for the same purpose,—one which comes up to the maximum, I may say, of the ability of directing light by this means. You are aware that without that arrangement of glass the light would be dispersed in all directions, but the lens being there, all the light which passes through it is thrown into parallel beams and cast horizontally along. There is consequently no loss of light, the beam goes forward of the same dimensions, and will consequently continue to go forward for 5 or 10 miles, or so long as the imperfection of the atmosphere does not absorb it; and see! What a glorious power that is, to be able to convert what was just now darkness on that paper into brilliant light.

Whenever we have refraction of this sort we are liable to an evil consequent upon the necessary imperfections in the form of the lens; and Dr. Tyndall will take this lens, and will show you even in this small and perfect apparatus what is the evil of spherical aberration with which we have to fight. This can be illustrated by means of the electric lamp; if you look at the screen, you will see produced, by means of this lens, a figure of the coal points. This image is produced by the rays which pass through the *middle* of the lens, a piece of card with a hole in the centre being placed in front; but if, keeping the rest of the apparatus in the same position, I change this card for another piece which will only allow the rays to pass through the *edge* of the lens, you observe how inferior the image will be. In order to get it distinct I have to bring the screen much nearer the lamp; and so

if I take the card away altogether, and allow the light to pass through all parts of the lens, we cannot get a perfect image, because the different parts of the lens are not able to act together. This spherical aberration is, therefore, what we try to avoid by building up compound lenses in the manner here shown (Fig. 4). Look at this beautiful apparatus, is it not a most charming piece of workmanship? Buffon first and Fresnel afterwards, built up these kinds of lenses, ring within ring, each at its proper adjustment, to compensate for the effects of spherical aberration; the ring round that centre lens is ground so as to obviate what would otherwise give rise to spherical aberration, and the next ring being corrected in the same manner, you will perceive, if you look at the disc of light thrown by the apparatus up-stairs, that there is nothing like the amount of aberration that there would have been if it had been one great bulls-eye. Here is one of Fresnel's lamps of the fourth order so constructed (Fig. 3): observe the fine effect obtained by these different lenses as you see them revolve before you, and understand that all this upper part is made to form part of the lens, each prism throwing its rays to increase the effect, and, although you may think it is imperfect because if you happen to sit below or above the horizontal line, you perceive but little if any of the light, yet you must bear in mind that we want the rays to go in a straight line to the horizon. So that all that building up of rings of glass is for the purpose of producing one fine and glorious lens of a large size, to send the rays all in one direction. Here is another apparatus used to pull the rays down to a horizontal sheet of light, so that the mariner may see it as a constant and uniform fixed light; the former lamp is a revolving one, and the light is seen only at certain times as the lenses move round, and these are the points which make them valuable in their application.

Fig. 3.



There are various orders and sizes of lights in light-houses to shine for twenty or thirty miles over the sea, and to give indications according to the purposes for which they are required; but suppose we want more effect than is produced by these means, how are we to get more light? Here comes the difficulty. We cannot get more light, because we are limited by the condition of the burner. In any of these cases, if the spreading of the ray, or *divergence* as it is called, is not restrained, it soon fails from weakness, and if it does not diverge at all, it makes the light so small that perhaps one in a hundred can see it at the same time. The North Foreland light-house is, I think, 3 or 400 feet above the level of the sea, and therefore it is necessary to have a certain divergence of the beam of light in order that it may shine along

the sea to the horizon. I have drawn here two wedges, one has an angle of 15°, and shows you the manner in which the light opens out from this reflector seen at the distance of half a mile or more, the other wedge has an angle of 6°, which is the beautiful angle of Fresnel. When the angle is less than 6°, the mariner is not quite sure that he will see the light—he may be beneath or above it; and in practice it is found that we cannot have a larger angle than 15°, or a less one than 6°. In order, therefore, to get more light, we must have more combustion, more cotton, more oil; but already there are in that lamp four wicks put in concentric rings, one within the other, and we cannot increase them much more, owing to the divergence which would be caused by an increase in the size of the light—the more the divergence, the more the light is diffused and lost. We are, therefore, restrained by the condition of the light and the apparatus to a certain sized lamp. At Teignmouth, some of the revolving lights have ten lamps and reflectors, all throwing their light forward at once. But even with ten lamps and reflectors we do not get sufficient light, and we want, therefore, a means of getting a light more intense than a candle in the space of a candle—not merely an accumulation of candle upon candle, but a concentration into the space of a candle, of a greater amount of light, and it is here that the electric light comes to be of so much value.

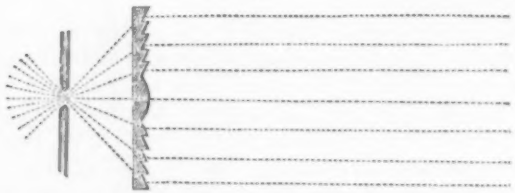
Let me now show you what are the properties of that light which make it useful for light-house illumination, and which has been brought to a practical condition by the energy and constancy of Prof. Holmes. I will first of all show you the image of the charcoal points on the screen, and draw your attention to the spot where the light is produced. There are the coal points. The two carbons are brought within a certain distance; the electricity is being urged across by the voltaic battery, and the coal points are brought into an intense state of ignition. You will observe that the light is essentially given by the carbons; you see that one is much more luminous than the other, and that is the end which principally form the spark, the other does not shine so much, and there is a space between the two, which, although not very luminous, is most important to the production of the light. Dr. Tyndall will help me in showing you that a blast of wind will blow out that light; the electric light can, in fact, be blown out easier than a candle. We have the power of getting our light where we please; if I cause the electricity to pass between carbon and mercury I get a most intense and beautiful light, most of it being given off from the portion of the mercury between the liquid and the solid pole. I can show you that the light is sometimes produced by the vapor between the two poles, better if I take silver than when I use mercury. Here is the carbon pole, there is the silver, and there is the beautiful green light which comes from the intervening portions. Now that light is more easily blown out than the common lamp, the slightest puff of wind being sufficient to extinguish it, as you will see if Dr. Tyndall breathes upon it.

You see, therefore, how we are able, by using this electric spark, to

get, first of all, the light into a very small space. That oil lamp has a burner 3¾ inches in diameter; compare the size of the flame with the space occupied by this electric light. Next compare the intensity of this light with any other; if I take this candle and place it by the side, I actually seem to put out the candle. We are thus able to get a light which, while it surpasses all others in brilliancy, is at the same time not too large, for I might put this light into an apparatus not larger than a hat, and yet I could count upon the rays being useful. Moreover, when such large burners are used in a lantern, we have to consider whether the bars of the window do not interfere to throw a shadow or otherwise; but with this light there will be no difficulty of that sort, as a single small speculum no larger than a hat will send it in any direction we please; and it is wonderful what advantages, by reason of its small bulk, we have in the consideration of the different kinds of apparatus required, reflecting or refracting, irrespective of other reasons for using the electric light. And it is these kind of things which make us decide most earnestly and carefully in favor of the electric light.

I am going to show you the effect that will take place with that large lens when we throw the oil lamp out of action, and put the electric light

Fig. 4.



into use. It is astonishing to find how little the eye can compare the relative intensities of two lights; look at that screen and try to recollect the amount of light thrown upon it from the 3¾ inch lamp of Fresnel, and now, when we shift the lens sideways, look at the glorious light arising from that small carbon point (Fig. 4); see how beautifully it shines in the focus of that lens and throws the rays forward. At present the electric light is put at just the same distance as the oil light, and therefore, being in the focus of the lens, we have parallel rays which are thrown forward in a perfectly straight line, as you will see by comparing the size of the lens with that of the light thrown on the screen. You will now see how far we can effect this beam of light by increasing or diminishing the distance of the lamp. We are able by a small adjustment to get a beam of a large or small angle, and observe what power I have now over it; for if I want to increase the degrees of divergence, I am limited by the power of light in the case of the oil lamp, but with the electric light I can make it spread over any width of the horizon by this simple adjustment. These then are some of the reasons which make it desirable to employ the electric light.

By means of a magnet, and of motion, we can get the same kind of electricity as I have here from the battery; and under the authority

of the Trinity House, Professor Holmes has been occupied in introducing the magneto-electric light in the light-house at the North Foreland; for the voltaic battery has been tried under every conceivable circumstance, and I take the liberty of saying it has hitherto proved a decided failure. Here, however, is an instrument wrought only by mechanical motion. The moment we give motion to this soft iron in front of the magnet, we get a spark. It is true in this apparatus it is very small, but it is sufficient for you to judge of its character. It is the *magneto-electric* light, and an instrument has been constructed as here shown (Fig. 5), which represents a number of magnets placed radially upon a wheel—three wheels of magnets and two sets of helices.

Fig. 5.

When the machine, which is worked by a two horse power engine, is properly set in motion, and the different currents are all brought together, and thrown by Professor Holmes up into the lantern, we have a light equal to the one we have been using this evening. For the last six months the North Foreland has been shining by means of this electric light—beyond all comparison better than its former light. It has shone into France, and has been seen there and taken notice of by the authorities, who work with beautiful accord with us in all these matters. Never for once during six months has it failed in doing its duty;—never once, more than was expected by the inventor. It has shone forth with its own peculiar character, and this even with the old apparatus—for as yet no attempt has been made to construct special reflectors or refractors for it, because it is not yet established. I will not tell you that the problem of employing the magneto-electric spark for light-house illumination is quite solved yet, although I desire it should be established most earnestly (for I regard this magnetic spark as one of my own offspring). The thing is not yet decidedly accomplished, and what the considerations of expense and other matters

may be, I cannot tell. I am only here to tell you as a philosopher, how far the results have been carried, but I do hope that the authorities will find it a proper thing to carry out in full. If it cannot be introduced at all the light-houses, if it can only be used at one, why really it will be an honor to the nation which can originate such an improvement as this,—one which must of necessity be followed by other nations.

You may ask, what is the use of this bright light? It would not be useful to us were it not for the constant changes which are taking place in the atmosphere, which is never pure. Even when we can see the stars clearly on a bright night it is not a pure atmosphere. The light of a light-house, more than any other, is liable to be dimmed by vapors and fogs, and where we most want this great power, is not in the finest condition of the atmosphere, but when the mariner is in danger, when the sleet and rain are falling, and the fogs arise, and the winds are blowing, and he is nearing coasts where the water is shallow and abounds with rocks—then is his time of danger, when he most wants this light. I am going to show you how, by means of a little steam, I can completely obscure this glorious sun, this electric light which you see. The cloud now obscuring the light on the screen is only such a cloud as you see when sitting in a train on a fine summer's day; you may observe that the vapor, passing out of the funnel, casts as deep a shadow on the ground as the black funnel; the very sun itself is extinguished by the steam from the funnel, so that it cannot give any light; and the sun itself if set in the light-house would not be able to penetrate such a vapor.

Now the haze of this cloud of steam is just what we have to overcome, and the electric light is as soon, proportionally, extinguished by an obstruction of this kind as any other light. If we take two lights, one four times the intensity of the other, and we extinguish half of one by a vapor, we extinguish half of the other, and that is a fact which cannot be set aside by any arrangement. But then we fall back upon the *amount* of light which the electric spark does give us in aid of the power of penetrating the fog, for the light of the electric spark shines so far at times, that even before it has arisen above the horizon twenty-five miles off, it can be seen. This intense light has, therefore, that power which we can take advantage of,—of bearing a great deal of obstruction before it is entirely obscured by fogs or otherwise.

Taking care that we do not lead our authorities into error by the advice given, we hope that we shall soon be able to recommend the Trinity House, from what has passed, to establish either one or more good electric lights in this country.

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*Increase of the Bite of Locomotives on Railways.**

In another part of our impression we give an account of an invention, with some experiments, of Mr. E. W. Serrell, an American civil engineer, from the *Journal of the Franklin Institute*, for increasing the bite of the engine wheels on the rails by means of electro-magnet-

* From Herapath's Railway Journal, No. 1071.

ism. Though we admit the importance of the invention, if generally practicable, we cannot see that it will allow of so much reduction in the weight of the locomotive, though it would of some, as the inventor seems to think. The power of the engine resides in its boiler, every part of which, with the working gear and driving wheels, must have strength with proportional weight to bear the full, and more than the full, strain of the steam in the boiler, and to resist the shocks occasioned by the velocity on the road. There is, however, one great benefit the invention would confer both upon the traveling public and the railway Companies. It would go far to lessen the number of accidents by the engine leaving the rails. For if the mutual adhesion between the wheels and rails be increased, the chances of the engine jumping off the rails will be diminished, and that would be more particulary so if the driving wheels, as we have heretofore recommended, were placed in the fore part of the engine. Coupled engines, too, which on curved lines produce great strains and consequent wear and tear, would be less needful if Mr. Serrell's invention could be brought into use.

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*On the Decay and Preservation of Building Materials.** By Prof. D. T. Ansted, M.A., F.R.S.

[The following Lecture was delivered at the Royal Institution on the 24th May, 1860.]

The subject of my present lecture is eminently practical, and hardly admits of much variety of illustration; but I am sure that none of you can have examined, or even glanced at the numerous specimens of architectural construction in the older and more picturesque cities of England and the Continent—you cannot have admired the graceful tracery of Westminster Abbey,—you cannot even have looked at the rich detail of the noble building recently erected so near it, by one whose genius will, perhaps, be willingly acknowledged, now that he has departed from amongst us, without noticing the facts I am about to refer to.

You will there see, at every turn, fresh proof of apparently capricious and unaccountable decay. You will find many old stones unaltered, while many new ones are fast mouldering into rottenness; and you will, I believe, be interested, in spite of the apparent dryness of the subject, in anything that will inform you about a result so painful, so irregular, and so desirable to check, if in any way prevention is possible.

Our building materials are of several kinds. Let me point out to you the principal varieties—their peculiar uses—their relative value for special purposes—and the special causes of decay in each. I shall then endeavor to put before you the modes by which such materials may be, at least in some measure, preserved from decay.

There is one thing which I may say with regard to all building materials of the nature of stone,—namely, that wherever it is found forming part of the earth's crust as a mass of rock, it is invariably,—if it comes to the surface at all—injured and altered near the surface. In

* From the Journal of the Society of Arts, No. 396.

a granite district, for example, where there is scarcely any soil lying over the granite, it scarcely ever happens that the upper portion of the granite does not, to a certain extent, exhibit marks of alteration. In all the common absorbent stones which are ordinarily used for building purposes, this is much more remarkably the case. And, to a certain extent, the rate at which the stone would be injured may be estimated by its appearance where it has been thus exposed for a long time to the action of the atmosphere. But that can only be taken as a partial measure of the injury likely to occur, because in some cases it will happen that the stone will stand exposure perfectly well in its own atmosphere, and when the surface only is exposed, without having been removed from the bed, although that same stone, when it is removed from the bed, particularly when it is placed in a different position from that which it occupied in the bed, will decay much more rapidly. Still, as I have said, it is an indication, and you will generally find that in a granite district a surface of good granite is exceedingly hard close to the top, and a decomposing granite worn and rotten. In a sandstone district there will also be a certain amount of decomposition dependent on the value of the stone. And in a limestone district there will generally be considerable decomposition; in fact the whole of the upper bed of limestone will be converted into vegetable soil.

Let us now take the building materials in regular order. First of all there is the group of which granite is the representative. A very remarkable group of stones is this, which are perfectly familiar to every one. With respect to it, therefore, I shall not waste your time in definitions, and merely remark that as it is one of the hardest, and, in some respects, one of the most valuable stones we have, yet in many respects, although very useful, it is almost impracticable for delicate ornamentation. Granite consists of a number of crystals embedded in a crystalline base. In other words, it is a mass of crystalline minerals crystallized altogether. That is the essential nature of granite, and the point in which it differs from most other stones. This explains at once its value, and the nature of its decay. Its value, because granite, being composed entirely of crystallized matter, is non-absorbent, and very little exposed to injury, so that there is no opportunity for decomposing agencies to get to it, without the lapse of a very long period of time. But it is also necessary to observe that granite consists of various kinds of crystals, and these not being always composed in the same manner, some are more liable to decay than others. Among the crystals that form granite are crystals of quartz, a material so durable that one hardly expects it to fail at all. But quartz, under certain circumstances, is capable of assuming a state in which, by the action of the weather, it will decay. This very peculiar state I shall speak of afterwards, when I have to ask your attention to some means of preventing decay. It is a fact—and I allude to it now as one of the ways in which granite appears subject to decay. A portion of quartz seems to be liable, in some states, to combine with water; and it then can be acted upon by alkalies and alkaline carbonates. More frequently it is the crystals of felspar, of which granite also consists in

a large measure, that decay. These consist of compound silicates, and the alkali among them is generally potash, but occasionally soda. When the alkali is soda, the stone is more likely to decay than when it is potash. Mica or talc, the other constituent of granite, is in a similar way liable to decomposition. Thus, although granite, as a stone, seems scarcely liable to injury, yet all the different parts of it are really capable of decay. With regard to the prevention of granite from decay, I do not know that it has ever been attempted. The only thing to be done is to select the better kinds, and you have only to go to the British Museum, and look at those wonderful specimens which have been delicately sculptured by the Egyptians, and afterwards exposed for so many centuries to a dry atmosphere, and now for some years to our own moist atmosphere, to observe how totally untouched they are. You have only to look at the various specimens of granite in our own metropolis, or in other parts of our island, and you cannot fail of being convinced how well it stands generally, although you may occasionally find unfavorable specimens.

Granite is a material which, owing to its great hardness, requires to be worked by pick and wedge; it cannot be worked merely by chisel and mallet. Owing to that it is expensive, and, generally speaking, cannot be used for ordinary purposes.

Next we come to the group of freestones. Freestones are either sandstones or limestones. The sandstones form a large group, but they are not very extensively used for the more decorative parts of buildings. They are at any rate little used in London, and there are many reasons for this. Sandstone consists for the most part of quartz sand, and I have told you that quartz forms a larger part of granite. But the particles of quartz in sandstone are cemented together by some foreign combining substance; sometimes this substance is silica, and in that case the stone will be almost unchangeable. Such is the sandstone that is worked in Edinburgh, and obtained at Craigleith. It is a stone which scarcely injures by exposure. Most of the sandstones, however, are cemented together, either by carbonate of lime, which has been filtered in by the action of water, by a mixture of clay and carbonate of lime introduced in the same manner, or by the presence of oxide of iron. All these cementing media are of course liable to the action of foreign substances upon them, according to their nature. And if these give way it is clear that the stone itself must give way. For an example of this kind of stone, that scarcely changes at all, I may direct your attention to a few specimens of the Yorkshire stones on the table before you. Although very excellent, however, these stones are not very manageable. They are difficult to work, and very hard. Although very durable, they vary, and are not quite free from the ordinary faults of sandstone. There is also before you a specimen of red stone (Mansfield) in which there is a considerable quantity of iron. The others are silica, with some mica, and are cemented by calcareous and argillaceous matter. They are thus liable to the ordinary action of weather and foreign substances upon them. In these stones the particles of silica rarely, if ever, give way, but

they are liable to fall away from each other by the decomposition of their cementing medium. But I was going to speak of the several kinds of sandstone before going into the causes of decay. The Yorkshire stones are the next in value after Craigleith, and are very good. Some of the dark-colored Scotch stones are also excellent. The stones from the coal measures are better than these red ones, which are not by any means advisable, and require to be used with care. There are a number of varieties of these red sandstones. All the sandstones used may be grouped in these three ways:—Those that are very hard, very compact, very fine in grain, and, generally speaking, of a pale color; these are durable but costly. Next, there are those that are hard and laminated. That is the character which belongs to almost all rocks that have been found in water, but in some it shows itself more markedly than in others. In stones which are completely laminated, the appearance is like sheets of paper placed one over the other, and you can almost separate them. Those stones are easily perishable. There are, however, laminated stones, such as those I am now referring to, of good quality. These are generally, not of very fine grain, although they may be so. They are most frequently of a mixed grain, made up of particles of sand and small pebbles of different sizes. Very often they have reddish tints of color, owing to the presence of iron, and they are often very irregular in their character. Lastly, there are some soft stones which are laminated, and generally red, but soft and bad. These are the three kinds of stone.

All these stones are subject to decay in this way:—First, from the lamination. Having been formed in water, they have been deposited in beds one over the other, and never become entirely free from water, and when exposed to the air are liable to give off the water by evaporation, and take it in again by absorption when rain comes, or when the atmosphere is damp. After this, if a change of temperature follows, and a severe cold sets in, the temperature of the stone passing below the point of the extreme density of water, the water begins to expand. That expansion before and whilst freezing, is one of the properties of water with which you are probably acquainted. You all know that if you leave water in a jug with a narrow neck, and frost sets in, the water will expand and break the jug. In the same way laminated and absorbent stones will break. The water gets in but cannot get out freely. It expands, and the stone breaks. Secondly, water entering in the manner I have described contains foreign substances. The water in the atmosphere that falls in the shape of rain is absorbed into the stone, and necessarily contains those foreign substances floating in the atmosphere which are soluble in water. These substances include a large number of gases—acid gases for the most part—but some others. For example, they include carbonic acid gas, and carbonic acid dissolves in water; they include, also, sulphurous acid passing into sulphuric acid, and this is taken up by the water. They include, also, ammonia. All these substances are abundantly produced in the atmosphere of large towns. These substances entering into the body of the stone, begin to act upon the cementing me-

dium. If the cementing medium is easily acted on chemically by these substances, it is of course very soon removed. If it is not easily affected by them, then the stone remains unaltered; but, generally speaking, it is the case that sandstones that have either lime or clay as their cementing medium, are more or less affected by foreign substances entering into them through the atmosphere. There is then a cause of decay in the sandstones, and the sandstones, when they are very absorbent, generally become readily disintegrated in this manner. Sandstones are not very extensively used in London for building, but they are very much employed in many parts of the country.

The next group includes what we call limestones. Limestones differ more in their nature than sandstones do, and include different kinds of material. For example, there are the carbonates of lime pure and the carbonates of lime and magnesia. First of all, I will take the carbonates of lime. Some of these are perfectly crystalline, such as marble. Marble has a very close texture; it does not absorb water, and it is, therefore, little acted upon by it unless it contains acids. When sound it lasts a long time, but if cracked, decay will enter in where the crack occurs. Marble is a very expensive stone, and the quantity of it compared with the other kinds of limestone is small; but there is a good deal of a sort of limestone intermediate between marble and common oolites. This is generally hard, and not unfrequently contains thin strings of foreign substances, as silica, which interfere with its working. Such stones are found in Derbyshire, and belong to what geologists call the carboniferous or mountain limestone series. They are crystalline, but irregular, being partially cracked and containing many fossils. A large majority of the limestones used in this country are oolites, so called because they appear to be made up of a number of eggs. These oolites are of various qualities. They are found in many parts of the country, and are commonly used for building, being, in fact, our common materials. There are several varieties of them which are of different value. One of the best is the Portland stone. There is a specimen upon the table, and a very good specimen it is. These stones are made up of a number of little particles, which are themselves groups of smaller particles. These little particles are cemented together by carbonate of lime, and the whole stone is nearly pure carbonate of lime. Portland is probably the best building stone we have in England, but is dear, being hard and expensive to work. St. Paul's Cathedral is built of Portland stone, and so is Greenwich Hospital, both being excellent examples. It is impossible, perhaps, to find better specimens of this stone than the Hospital. A few days before his death, I was with Sir Charles Barry at Greenwich Hospital, and he was pointing out to me the beautiful condition of the stone on the east face. It is, indeed, worth looking at as a specimen of the material, and is almost, if not quite, equal to the marble of which the Milan Cathedral is built. There are many other good specimens of this stone in London, and of these the Reform Club is as good as any. If you look at these specimens of

the better kind, you will hardly recognise the decay that takes place. You must look at stones which have been a long time exposed, or else at an inferior quality of material. Bath stones offer a wonderful contrast to Portland. Bath stone is almost as soft as cheese in the quarry, and it can then be cut with an ordinary knife. I speak now of the stones in the quarry, where all stones are softer and more easily worked than when they have been exposed for some time to the air. Bath stone, being exceedingly soft, is therefore cheap. It is easily got and easily cut, but it is not a stone that wears well. Some specimens of Bath stone are to be seen in the recent restorations of Westminster Abbey that have failed so completely as to be already a great deal worse than much of the stone that has been there for centuries. Within the few years that have elapsed since this stone was put up, it has decayed entirely. And yet stones of the same kind, from nearly the same quarry—indeed some from the identical quarries—have been used in the City of Bath, and are not much the worse after a century's wear. There is a difference in the quality of the stone, but there is also a great difference in the quality of the air to which stones are exposed. The rapid decay may, however, be partly attributed to the fact that the stones for Westminster Abbey had not been well selected, and perhaps the stones used at Bath had been for some time exposed to the air before use. Bath stone is, as I have said, an exact opposite to Portland. But we have other stones that are bad. I do not know that I can mention a more remarkable instance than the stone which is obtained at Heddington, in the neighborhood of Oxford. There are some specimens of the different oolites on the table, and the Heddington is in some respects the worst of all. No one, I think, can have looked at some of the older buildings in Oxford without seeing what a bad state they are in, and how bad the stone itself must be. I have here a specimen of Heddington stone, that has been exposed for a short time to the action of acids, and it shows the way in which such stones will decay. Besides these there are a number of stones of intermediate quality in England, known by various names—the names of the quarries in which they are found. There is the Ancaster stone, the Ketton stone, the Barnack stone, and the Purbeck stone. There is another limestone to which I wish to direct your attention—that is the Caen stone. A vast quantity of stone has been obtained, from time immemorial, from some of the quarries in the neighborhood of Caen, and some other places near. This stone has been brought over to England almost from the time of the Norman conquest. Part of Canterbury Cathedral is built of it, and it has stood very well. But other stones from the same or from adjacent quarries have gone entirely. They have failed so thoroughly that it is impossible to conceive any thing worse. They are even worse than the Heddington stone in the worst cases in Oxford. There is a specimen before me of Caen stone showing decay; it shows the quality of the stone, and it shows the way in which decay takes place. This, however, although a decayed stone, is not a bad specimen. I could not get the sort of specimen I should have been glad of, to show how badly some Caen

stone decays. But there have been some buildings erected lately in London, and I am sorry to say that one of them is Buckingham Palace, that show the decay as clearly as can be. Soon after the palace was completed, the stone became in so bad a state that it was positively dangerous for the sentinels to walk underneath it, and it was necessary to remove large portions of it and to substitute stucco; and there it remains to this day painted over. This case, with regard to a common limestone will show what sort of material we have to deal with. All the cheaper kinds of stone are exceedingly liable to decay.

How does limestone decay? It decays in a very simple way, and from the same causes that I alluded to in speaking of sandstones.—First there is an exposure to changing temperature, all the limestones being absorbent, and taking in a certain quantity of water. The water is driven in by rain, particularly in what appear to be the sheltered parts of the stone, beneath projections. Then cold comes, and even if the stone has been placed in the building as it lays in the bed, there will still be a tendency to throw off successive laminæ, but if put carelessly in the building, or fixed at right angles to the position it was in the bed, so that what was originally the plane of the bed has now become vertical, the effect will be that the whole face of the stone will peal off, and if the stone is cut into delicate ornaments, it is almost inevitable that some of the planes of the bed would interfere, so that when expansion takes place, the outer laminæ of the ornament would break off and fall away. The moment that is done in any one place, absorption becomes more rapid than it was before, and it goes on with increasing rapidity. If, however, the stone lasts for a certain time without injury, the surface hardens. All stone is much harder after it has been exposed to the air for some time than it is in the quarry; and, therefore, if it once gets into this state it may last, but if it is attacked early it will go. There is an instance of this to be seen in Mr. Hope's house, in Piccadilly, which is built of a soft stone. It has been sheltered by putting leads over the tops of the exposed parts; and I have Mr. Charles Smith's authority for saying that, in consequence of that, the stone has been preserved. The water has been prevented from draining down into the stone, and in that way it has had time to harden. The water that is absorbed when limestone is exposed to the air is charged with acids, as I have already mentioned, and under these circumstances the stone acts as a kind of filter. A porous stone acts also in another way, decomposing the gases that pass into it. A certain, though slow, decomposition thus goes on, and the stone becomes actually destroyed. Very often this will take place even when it is not very apparent outside. That is the case especially in some of the Heddington stones. At Oxford you will often see large scales breaking off from the surface of the building, although the outside is apparently pretty good. This is the result of that amount of decomposition and alteration that goes on within the substance of the stone itself.

There is another kind of limestone which I must mention. It is magnesian limestone. The magnesian limestone is carbonate of lime

and magnesia; common limestone is simply carbonate of lime. Just as the common limestone when crystallized is very durable, so magnesian limestone, when crystallized (in which case it is composed of equal parts of carbonate of lime and carbonate of magnesia), is in a more compact state than when earthy, and then seems to stand exceedingly well. In the places where these stones are obtained, the churches built of them centuries ago are quite unaltered. But when these same stones are brought into our London atmosphere, although they appear to be just as good, and are exposed to very much the same influences, they begin at once to decay. It was owing to a neglect of the consideration of this matter that the stone used for the construction of the Houses of Parliament has suffered so much. The stone for this purpose was selected with the greatest possible consideration. A commission was appointed of the fittest men of the time—the best geologist, the architect, competent practical men, and the best chemists. All those employed were men of the highest reputation, and no one has hinted for a moment that they did not do their duty. This commission examined the different limestones in the country, and they recommended the magnesian limestone of Bolstover, because they believed it to be the best. They found buildings constructed of it many centuries ago entirely unaltered, and they naturally recommended that it should be employed. Then came a difficulty which had not been considered sufficiently, and that was that the particular quarries which had supplied the stone to the churches in the neighborhood were by no means large enough to supply the quantity required for the Houses of Parliament; and not only that, but it was not at all certain that other stones could be got in the immediate neighborhood of precisely the same kind. Other quarries adjacent were selected, and the stone which was used was certainly from the neighborhood, and nominally the same stone, but really it was exceedingly imperfect. Magnesian limestone differs from common limestone in the way in which it decays. Under the action of those causes that I have already mentioned, it decays whenever the two minerals are not perfectly crystallized together, and then it becomes disintegrated and powdery, so that in one block you will find portions which are perfectly hard, and other portions near them, which are also hard, whilst between these two you will find portions which are perfectly soft, and so disintegrated that the particles might almost be blown away by the wind. This has arisen from the way in which the material was originally crystallized, and from the difficulty that there is in producing a perfect crystallization in a mass on a large scale in nature. Generally speaking, there is a considerable amount of variety both in the composition and subsequent metamorphosis of rocks, so that bedded materials almost always vary a great deal even in a short distance. This is the case with magnesian limestone, but it also appears that neglect was incurred by the want of sufficient superintendence in selecting the best kinds of stone, and rejecting bad samples either at the quarry or in London. There was no sufficient superintendence, and the poor and inferior specimens of stone were not rejected. They were all put into this

great building, and the result is that some of the stones are very good, some very indifferent, and some exceedingly bad. The same kind of stone was used in the new building of Lincoln's-inn, and it is even worse. The same kind of stone, however, is used in the construction of the Museum of Practical Geology, in Jermyn-street, and there there is not a stone faulty. It would appear then that the selection of stone is a very important matter. So much I may say with regard to the materials and the nature of the causes that produce their decay.

Practically, then, the causes of decay of absorbent stones are connected with exposure to damp atmosphere, rendered impure by various acids and alkaline gases, and also with changes of temperature, especially above and below the temperature of about 38 degrees, at which water attains its greatest density. It is quite clear that where there is a large amount of injurious gases present in the air, in other words in and near large cities, where there are a great number of people breathing and giving off carbonic acid gas, and where a large number of fires are burning, which always yield a large quantity of sulphurous acid, and also where there is much ammonia; in these places, and owing to the state of the atmosphere, stones which in the open country would stand perfectly well, will stand very badly. In addition to this must be taken into account the exposure to certain winds, and the action of the weather to a greater or less extent for a limited time.

(To be Continued.)

MECHANICS, PHYSICS, AND CHEMISTRY.

*The Mechanical Theory of Heat.** By Daniel K. Clark, C. E.

An important an interesting inquiry relative to steam and its operation in the steam engine, is that which traces the connexion between the heat expended and the dynamical effect, or work, produced. The method of separate condensation, and the application of the force of expanding steam, changed to an important extent the accepted relations of heat to power, and added remarkably to the dynamical effect of the fuel; and though the steam engine has been progressively improved by the continual elaboration of small economies, there is yet good reason to believe that the field of improvement is wide, and that the laborer in that field has the prospect of a good return. The inquiries of scientific men on the subject of the relation of heat to mechanical effect have resulted in the establishment of the principle that heat and mechanical force are identical and convertible, and that the action of a given quantity of heat may be represented by a constant quantity of mechanical work performed. "Motion and force," says Professor Rankine, "being the only phenomena of which we thoroughly and exactly know the laws, and mechanics the only complete physical science, it has been the constant endeavor of natural philosophers, by conceiving the other phenomena of nature as modifications of mo-

*From the Lond. Engineer, No. 232.

tion and force, to reduce the other physical sciences to branches of mechanics. Newton expresses a wish for the extension of this kind of investigation. The theory of radiant heat and light having been reduced to a branch of mechanics by means of the hypothesis of undulations, it is the object of the hypothesis of molecular vortices"—oscillation of vibratory motion—"to reduce the theory of thermometric heat, and elasticity also, to a branch of mechanics, by so conceiving the molecular structure of matter that the laws of these phenomena shall be the consequences of those of motion and force. This hypothesis, like all others, is neither demonstrably true nor demonstrably false, but merely probable in proportion to the extent of the class of facts with which its consequences agree." It must, however, be remarked that, whether the hypothesis of molecular motion be probable or improbable, the theoretical and practical results arrived at in regard to the mechanical action of heat remaining unaffected, being deduced from principles which have been established by experiment and demonstration. From these principles, Professor Rankine announced the specific heat of air before it was otherwise known—the accuracy of his deductions having since been verified to within less than 1 per cent. by the experiments of Regnault. The best experiments, previous to those made by Regnault, in regard to the specific heat of air, were those of Delaroche and Berard, from which they deduced a specific heat of ·266; but arguing from the mechanical theory of heat, Professor Rankine declared that this value must be erroneous, and that the specific heat of air could not exceed ·240. It has been found accordingly, by Regnault, since the statement was made, as the result of a hundred experiments, that the specific heat of air was ·238, and that it is constant for all pressures from one to ten atmospheres, or at least differs almost inappreciably. This coincidence of theoretical prediction with experimental evidence, it has been well observed, should have something like the same tendency in strengthening our belief of the theory upon which Prof. Rankine's estimate was based, as the discovery of an unknown planet, previously indicated by Le Verrier and Adams, had in confirming our faith in the science of astronomy.

The principle of the dynamical or mechanical theory of heat, as already stated, is that, independently of the medium through which heat may be developed into mechanical action, the same quantity of heat converted is invariably resolved in the same total quantity of mechanical action. For the exact expression of this relation, of course units of measure are established, in terms of the English foot, as the measure of space; the pound avoirdupois, as the measure of weight, pressure, elasticity; and the degree of Fahrenheit's scale, as the measure of temperature and heat. Work done consists of the exertion of pressure through space, and the English unit of work is the exertion of 1 lb. of pressure through 1 ft., or the raising of 1 lb. weight through a vertical height of 1 ft.—briefly, a foot-pound. The unit of heat is that which raises the temperature of 1 lb. of ordinary cold water by 1 deg. Fah. If 2 lbs. of water be raised 1 deg., or 1 lb. be

raised 2 deg. in temperature, the expenditure of heat is, equally in both cases, two units of heat. Similarly, if 1 lb. weight be raised through 1 ft., or 2 lbs. weight be raised through 2 ft., the power expended, or work done, is equally in both cases two units of work, or two foot-pounds. From these definitions, then, the comparison lies between the unit of heat, on the one part, and the unit of work, or the foot-pound, on the other. M. Clapeyron, in his treatise on the moving power of heat, and M. Noltzman, of Manheim, in 1845, who availed himself of the labors of M. Clapeyron and M. Carnot in the same field, grounding their investigations on the received laws of Boyle or Marriotte, and Gay-Lussac, which express the observed relations of heat, elasticity, and volume in steam and other gaseous matter, concluded that the unit of heat was capable of raising a weight, between the limits of 626 lbs. and 782 lbs. 1 ft. high; that is to say, that one unit of heat was equivalent to from 626 to 782 foot-pounds. By this mode of investigation, they suppose a given weight of steam or gaseous matter to be contained in a vertical cylinder formed of non-conducting material, in which is fitted an air-tight but freely moving piston, which is pressed downward by a weight equal to the elasticity of the gas. Now, the weight, initial temperature, pressure, and volume being known, a definite quantity of heat from without is supposed to be imparted to the vapor; and the result is partly an elevation of the temperature of the vapor, and partly a dilation or increase of volume; or, in other words, an exertion of pressure through space, the elasticity remaining the same. But the result may be represented entirely by dilation, so that there shall not be any final alteration of temperature; and for this purpose it is only necessary to allow the vapor to dilate without any loss of its original or imparted heat until it re-acquires its initial temperature. In this case, the ultimate effect is purely dilatation, or motion against pressure; and the work done is represented by the product of that pressure into the space moved through.

Mr. Joule, of Manchester, in 1843–47, proceeded, by entirely different, independent, and, in fact, purely experimental methods, to investigate the relation of heat and work. 1st. By observing the calorific effects of magneto-electricity. He caused to revolve a small compound electro-magnet immersed in a glass vessel containing water between the poles of a powerful magnet: heat was proved to be excited by the machine by the change of temperature in the water surrounding it, and its mechanical effect was measured by the motion of such weights as by their descent were sufficient to keep the machine in motion at any assigned velocity. 2d. By observing the changes of temperature produced by the rarefaction and condensation of air. In this case, the mechanical force producing compression being known, the heat excited was measured by observing the changes of temperature of the water in which the condensing apparatus was immersed. 3d. By observing the heat evolved by the friction of fluids. A brass paddle-wheel, in a copper can containing the fluid, was made to revolve by descending weights. Sperm oil and water yielded the same results. Mr. Joule considered the third method the most likely to afford accu-

rate results; and he arrived at the conclusion that one unit of heat was capable of raising 772 lbs. 1 ft. in height; or that the mechanical equivalent of heat was expressible by 772 foot-pounds for one unit of heat—known as "Joule's equivalent."

The following are the values of Joule's equivalent for different thermometric scales, and in English and French units:—

1 English thermal unit, or 1 deg. Fah. in 1 lb. of water,	772 foot-pounds.
1 centigrade degree in 1 lb. of water, . . .	1389·6 "
1 French thermal unit, or 1 centigrade degree in a kilogramme of water, ...	423·55 kilogrammetres.

The mechanical theory of heat rests upon a wide basis, and proofs in verification of the theory are constantly accumulating. When the weight of any liquid whatever is known, with the comparative weight of its vapor at different pressures, the latent heat at the different pressures is readily estimated from the theory; and this method of estimation agrees with the best experimental results, as may afterwards be shown; and when the latent heat is also known, the specific heat of the liquid can be determined by means of the same theory; in other words, the quantity of work, in foot-pounds, may be determined, which would, by agitating the liquid or by friction, be required to raise the temperature of any given quantity of the liquid by, say, one degree, altogether independently of Joule's experiments. The theory enables us to discover the utmost power it is possible to realize from the combination of any given weight of carbon and oxgyen, or other elementary substances, with nearly as much precision as we can estimate the utmost quantity of work it is possible to obtain from a known weight of water falling through a given height. It is not difficult to comprehend, then, that the theory of the mechanical equivalent of heat proves of great practical utility.

According to the mechanical theory of heat, in its general form, heat, mechanical force, electricity, chemical affinity, light, sound, are but different manifestations of motion. Dulong and Gay-Lussac proved by their experiments on sound, that the greater the specific heat of a gas, the more rapid are its atomic vibrations. Elevation of temperature does not alter the rapidity, but increases the length of their vibrations, and in consequence produces "expansion" of the body. All gases and vapors are assumed to consist of numerous small atoms, moving or vibrating in all directions with great rapidity; but the average velocity of these vibrations can be estimated when the pressure and weight of any given volume of gas is known, pressure being, as explained by Joule, the impact of those numerous small atoms striking in all directions, and against the sides of the vessel containing the gas. The greater the number of these atoms, or the greater their aggregate weight, in a given space, and the higher the velocity, the greater is the pressure. A double weight of a perfect gas, when confined in the same space, and vibrating with the same velocity—that is, having the same temperature—gives a double pressure; but the same weight of gas, confined in the same space, will, when the atoms vibrate with a double velocity, give a quadruple pressure. An increase

or decrease of temperature is simply an increase or decrease of molecular motion. The truth of this hypothesis is very well established, as already intimated, by the numerous experimental facts with which it is in harmony.

When a gas is confined in a cylinder under a piston, so long as no motion is given to the piston, the atoms, in striking, will rebound from the piston after impact with the same velocity with which they approached it, and no motion will be lost by the atoms. But when the piston yields to the pressure, the atoms will not rebound from it with the same velocity with which they strike, but will return after each succeeding blow, with a velocity continually decreasing as the piston continues to recede, and the length of the vibrations will be diminished. The motion gained by the piston will, it is obvious, be precisely equivalent to the energy, heat, or molecular motion lost by the atoms of the gas. Vibratory motion or heat being converted into its equivalent of onward motion, or dynamical effect, the conversion of heat into power, or of power into heat, is thus simply a transference of motion; and it would be as reasonable to expect one billiard-ball to strike and give motion to another without losing any of its own motion, as to suppose that the piston of a steam engine can be set in motion without a corresponding quantity of energy being lost by some other body.

In expanding air spontaneously to a double volume, delivering it, say, into a vacuous space, it has been proved repeatedly that the air does not fall appreciably in temperature, no external work being performed; but, on the contrary, if the air at a temperature, say, of 230 deg. Fah., be expanded under pressure or resistance, as against the piston of a cylinder, giving motion to it, raising a weight, or otherwise doing work by giving motion to some other body, the temperature will fall nearly 170 deg. when the volume is doubled; that is, from 230 deg. to about 60 deg., and taking the initial pressure of 40 lbs., the final pressure would be 15 lbs. per square inch.

When a pound weight of air, in expanding at any temperature or pressure, raises 130 lbs. 1 ft. high, it loses 1 deg. in temperature; in other words, this pound of air would lose as much molecular energy as would equal the energy acquired by a weight of 1 lb. falling through a height of 130 ft. It must, however, be remarked that but a small portion of this work, 130 foot-pounds can be had as available work, as the heat which disappears does not depend on the amount of work or duty realized, but upon the total of the opposing forces, including all resistance from any external source whatever. When air is compressed, the atmosphere descends and follows the piston, assisting in the operation with its whole weight; and when air is expanded, the motion of the piston is, on the contrary, opposed by the whole weight of the atmosphere, which is again elevated. Although, therefore, in expanding air, the heat which disappears is in proportion to the total opposing force, it is much in excess of what can be rendered available; and, commonly, where air is compressed the heat generated is much greater than that which is due to the work which is required to be expended, the weight of the atmosphere assisting in the operation.

Let a pound of water, at a temperature of 212 deg. Fah., be injected into a vacuous space or vessel, having 26·36 cubic feet of capacity—the volume of 1 lb. of saturated steam at that temperature—and let it be evaporated into such steam, then 893·8 units of heat would be expended in the process. But if a second pound of water, at 212 deg., be injected and evaporated at the same temperature, under a uniform pressure of 14·7 lbs. per square inch due to the temperature, the second pound must dislodge the first, by repelling that pressure, involving an amount of labor equal to 55,800 foot-pounds (that is, 14·7 lbs. × 144 square inches × 26·36 cubic feet), and an additional expenditure of 72·3 units of heat (that is, 55,800 ÷ 772), making a total for the second pound of 965·1 units.

Similarly, when 1408 units of heat are expended in raising the temperature of air at constant pressure, 1000 of the units increase the velocity of the molecules, or produce a sensible increment of temperature; while the remaining 408 parts, which disappear as the air expands, are directly expended in repelling the external pressure.

Again, if steam be permitted to flow from a boiler into a comparatively vacuous space, without giving motion to another body, the temperature of the steam entering this space would rise much higher than that of the steam in the boiler. Or, suppose two vessels side by side, one of them vacuous, and the other filled with air at, say, two atmospheres, a communication being opened between the vessels, the pressure would become equal in the two vessels; but the temperature would fall in one vessel and rise in the other; and although the air is expanded in this manner to a double volume, there would not on the whole be any appreciable loss of heat, for if the separate portions of air be mixed together, the resulting average temperature of the whole would be very nearly the same as at first. It has been proved experimentally, corroborative of this argument, that the quantity of heat required to raise the temperature of a given weight of air to a given extent, was the same, irrespective of the density or volume of the air. Regnault and Joule found that, to raise the temperature of a pound weight of air 1 cubic foot in volume, or 10 cubic feet, the same quantity of heat was expended.

In rising against the force of gravity steam becomes colder, and partially condenses while ascending in the effort of overcoming the resistance of gravity by the conversion of heat into water. For instance, a column of steam weighing, on a square inch of base, 250·3 lbs.—that is, a pressure of 250·3 lbs. per square inch—would, at a height of 275,000 feet, be reduced to a pressure of 1 lb. per square inch, and in ascending to this height, the temperature would fall from 401 deg. to 102 deg. Fah., while at the same time, nearly 25 per cent. of the whole vapor would be precipitated in the form of water, if not supplied with heat while ascending.

If a body of compressed air be allowed to rush freely into the atmosphere, the temperature falls in the rapid part of the current by the conversion of heat into motion, but the heat is almost all reproduced when the motion is quite subsided; and from recent experiments it

appears that nearly similar results are obtained from the emission of steam under pressure.

When water falls through a gaseous atmosphere its motion is constantly retarded as it is brought into collision with the particles of that atmosphere, and by this collision it is partly heated and partly converted into vapor.

If a body of water descends freely through a height of 772 ft., it acquires from gravity a velocity of 223 ft. per second; and if suddenly brought to rest when moving with this velocity, it would be violently agitated, and raised 1 degree in temperature. But suppose a water-wheel, 772 ft. in diameter, into the buckets of which water is quietly dropped, when the water descends to the foot of the fall, and is delivered gently into the tail-race, it is not sensibly heated. The greatest amount of work it is possible to obtain from water falling from one level to another lower level is expressible by the weight of water multiplied by the height of the fall.

The object of these illustrative exhibitions of the nature and reciprocal action of heat and motive power, with their relations, are—first, to familiarize the reader with the doctrine of the mechanical equivalence of heat; second, to show that the nature and extent of the change of temperature of a gas while expanding, depends nearly altogether upon the circumstances under which the change of volume takes place.

A Course of Lectures, consisting of Illustrations of the Various Forces of Matter, i.e. *of such as are called the Physical or Inorganic Forces.** By M. Faraday, D. C. L., F. R. S.

Lecture III. (Jan. 4, 1860.)—*Cohesion.—Chemical Affinity.*

We will first of all return for a few minutes to one of the experiments which we made yesterday. You remember what we put together on that occasion?—Powdered alum and warm water; here is one of those basins; nothing has been done to it since then, but you will find on examining it that it no longer contains any powder, but a multitude of beautiful crystals. Here also are the pieces of coke which I put into the other basin; these have a fine mass of crystals about them. That other basin I will leave as it is; I will not pour the water from it, because it will show you that the particles of alum have done something more than merely crystallize together. They have pushed the dirty matter from them, laying it around the outside or outer edge of the lower crystals—squeezed out, as it were, by the strong attraction which the particles of alum have for each other.

And now for another experiment. We have already gained a knowledge of the manner in which the particles of bodies—of solid bodies—attract each other, and we know that it makes calcareous spar, alum, and so forth, crystallize in these regular forms. Now, let me gradually lead your minds to a knowledge of the means we have of making this

* From the Lond. Chemical News, No. 7.

attraction alter a little in its force; either of increasing or diminishing, or apparently of destroying it altogether. I will take this piece of iron [a rod of iron about two feet long and a quarter of an inch in diameter], it has at present a great deal of strength, due to its attraction of cohesion; but if Mr. Anderson will make part of this rod hot in the fire, we shall then find that it will become soft, just as sealing-wax will when heated, and we shall also find that the more it is heated the softer it becomes. Ah! but what does *soft* mean? Why, that the attraction between the particles is so weakened that it is no longer sufficient to resist the power we bring to bear upon it. [Mr. Anderson handed to the Lecturer the iron rod, with one end red hot, which he showed could be easily twisted about with a pair of pliers.] You see, I now find no difficulty in bending this end about how I like; whereas I cannot bend the cold part at all. And you know how the smith takes a piece of iron and heats it, in order to render it soft for his purpose; he acts upon our principle of lessening the adhesion of the particles, although he does not know exactly the terms in which we express it.

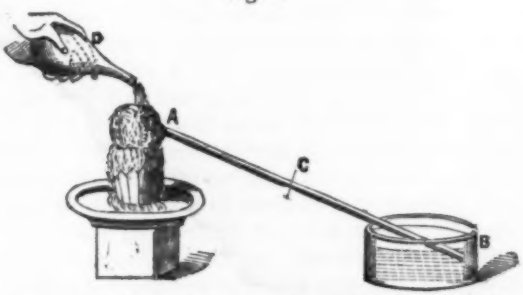
And now we have another point to examine; and this water is again a very good substance to take as an illustration (as philosophers we call it all water, even though it be in the form of ice or steam). Why is this water hard? [pointing to a block of ice] because the attraction of the particles to each other is sufficient to make them retain their place in opposition to force applied to it. But what happens when we make the ice warm? Why, in that case we diminish to such a large extent the power of attraction that the solid substance is destroyed altogether. Let me illustrate this: I will take a red-hot ball of iron [Mr. Anderson, by means of a pair of tongs, handed to the Lecturer a red-hot ball of iron, about two inches diameter] because it will serve as a convenient source of heat [placing the red-hot iron in the centre of the block of ice]. You see I am now melting the ice where the iron touches it. You see the iron sinking into it, and while part of the solid water is becoming liquid, the heat of the ball is rapidly going off. A certain part of the water is actually rising in steam—the attraction of some of the particles is so much diminished that they cannot even hold together in the liquid form, but escape as vapor. At the same time you see I cannot melt all this ice by the heat contained in this ball. In the course of a very short time I shall find it quite cold.

Here is the water which we have produced by destroying some of the attraction which existed between the particles of the ice, for below a certain temperature the particles of water increase in their mutual attraction and become ice; and above a certain temperature the attraction decreases and the water becomes steam. And exactly the same thing takes place with platinum, and nearly every substance in nature; if the temperature is increased to a certain point it becomes liquid, and a further increase makes it a gas. Is it not a glorious thing for us to look at the sea, the rivers, and so forth, and to know that this same body in the northern regions is all solid ice and ice-bergs, while here in a warmer climate it has its attraction of cohesion so much diminished

as to be liquid water? Well, in diminishing this force of attraction between the particles of ice, we made use of another force, namely, that of *heat*, and I want you now to understand that this force of heat is always concerned when water passes from the solid to the liquid state. If I melt ice in *other* ways I cannot do without heat; (for we have the means of making ice liquid without heat; that is to say, without using heat as a *direct* cause.) Suppose, for illustration, I make a vessel out of this piece of tin foil [bending the foil up into the shape of a dish]. I am making it metallic, because I want the heat which I am about to deal with to pass readily through it;—and I am going to pour a little water on this board, and then place the tin vessel on it. Now if I put some of this ice into the metal dish, and then proceed to make it liquid by any of the various means we have at our command, it still must take the necessary quantity of heat from something, and in this case, it will take the heat from the tray, and from the water underneath, and from the other things round about. Well, a little salt added to the ice has the power of causing it to melt, and we shall very shortly see the mixture become quite fluid, and you will then find that the water beneath will be frozen—frozen because it has been forced to give up that heat which is necessary to keep it in the liquid state, to the ice on becoming liquid. I remember once, when I was a boy, hearing of a trick in a country ale-house; the point was how to melt ice in a quart pot by the fire, and freeze it to the stool. Well, the way they did it was this: they put some pounded ice in a pewter pot and added some salt to it, and the consequence was that when the salt was mixed with it, the ice in the pot melted (they did not tell me anything about the salt, and they set the pot by the fire, just to make the result more mysterious), and in a short time the pot and the stool were frozen together, as we shall very shortly find it to be the case here, and all because salt has the power of lessening the attraction between the particles of ice. Here you see the tin dish is frozen to the board, I can even lift this little stool up by it.

This experiment then cannot, I think, fail to impress upon your minds the fact, that whenever a solid body loses some of that force of

Fig. 1.



attraction by means of which it remains solid, heat is absorbed; and if, on the other hand we convert a liquid into a solid, *e.g.*, water into ice, a corresponding amount of heat is given out. I think an experi-

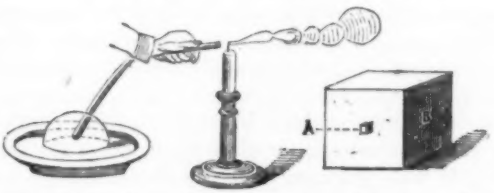
ment of this kind will serve to show you this. Here (Fig. 1) is a bulb A, filled with air, the tube from which dips into some colored liquid in the vessel B. And I dare say you know that if I put my hand on the bulb A, and warm it, the colored liquid which is now standing in the tube at C will travel forward. Now we have discovered a means, by great care and research into the properties of various bodies, of preparing a solution of a salt which if shaken or disturbed will at once become a solid; and as I explained to you just now (for what is true of water is true of every other liquid), by reason of its becoming solid, heat is evolved, and I can make this evident to you by pouring it over this bulb;—there! it is becoming solid, and look at the colored liquid, how it is being driven down the tube, and how it is bubbling out through the water at the end; and so we learn this beautiful law of our philosophy, that whenever we diminish the attraction of cohesion we absorb heat—and whenever we increase that attraction heat is evolved. This, then, is a great step in advance, for you have learned a great deal in addition to the mere circumstance that particles attract each other. But you must not now suppose that because they are liquid they have lost their attraction of cohesion; for here is the fluid mercury, and if I pour it from one vessel into another I find that it will form a stream from the bottle down to the glass—a continuous rod of fluid mercury, the particles of which have attraction sufficient to make them hold together all the way through the air down to the glass itself; and if I pour water quietly from a jug I can cause it to run in a continuous stream in the same manner. Again, let me put a little water on this piece of plate glass, and then take another plate of glass and put it on the water; there! the upper plate is quite free to move, gliding about on the lower one from side to side; and yet, if I take hold of the upper plate and lift it up straight, the cohesion is so great that the lower one is held up by it. See how it runs about it as I move the upper one, and this is all owing to the strong attraction of the particles of the water. Let me show you another experiment. Suppose I take a little soap and water—not that the soap makes the particles of the water more adhesive one for the other, but it certainly has the power of continuing in a better manner the attraction of the particles; (and let me advise you, when about to experiment with soap bubbles to take care to have every thing clean and soapy.) I will now blow a bubble, and that I may be able to talk and blow a bubble too, I will take a plate with a little of the soap-suds in it, and will just soap the edges of the pipe, and blow a bubble on to the plate. Now, there is our bubble. Why does it hold together in this manner? Why, because the water of which it is composed has an attraction of particle for particle:—so great, indeed, that it gives to this bubble the very power of an india-rubber ball; for you see, if I introduce one end of this glass tube into the bubble that it has the power of contracting so powerfully as to force enough air through the tube to blow out a light (Fig. 2)—there is a light blown out. And look! see how the bubble is disappearing; see how it is getting smaller and smaller.

There are twenty other experiments I might show you to illustrate

this power of the cohesion of the particles of liquids. For instance, what would you propose to me, if, having lost the stopper out of this alcohol bottle, I should want to close it speedily with something near at hand. Well, a bit of paper would not do, but a piece of linen cloth would, or some of this cotton wool which I have here. I will put a tuft of it into the neck of the alcohol bottle, and you see when I turn it upside down, that it is perfectly well stoppered so far as the alcohol is concerned; the air can pass through but the alcohol cannot. And if I were to take an oil vessel this plan would do equally well, for in former times they used to send us oil from Italy in flasks stoppered only with cotton wool (at the present time the cotton is put in after the oil has arrived here, but formerly it used to be sent so stoppered). Now if it were not for the particles of liquid cohering together, this alcohol would run out, and if I had time I could have shown you a vessel with the top, bottom, and sides altogether formed like a sieve, and yet it would hold water owing to this cohesion.

You have now seen that the solid water can become fluid by the addition of heat, owing to this lessening the attractive force between its particles, and yet you see that there is a good deal of attractive force remaining behind. I want now to take you a step beyond that. We

Fig. 2. Fig. 3.



saw that if we continued applying heat to the water (as indeed happened with our piece of ice here) that we did at last break up that attraction which holds the liquid together, and I am going to take some ether (any other liquid would do, but ether makes a better experiment for my purpose) in order to illustrate what will happen when this cohesion is broken up. Now this liquid ether, if exposed to a very low temperature, will become a solid, but if we apply heat to it, it becomes vapor, and I want to show you the enormous bulk of the substance in this new form:—when we make ice into water, we lessen its bulk, but when we convert water into steam, we increase it to an enormous extent. You see it is very clear that as I apply heat to the liquid I diminish its attraction of cohesion—it is now boiling, and I will set fire to the vapor, so that you may be enabled to judge of the space occupied by the ether in this form by the size of its flame, and you now see what an enormously bulky flame I get from that small volume of ether below. The heat from the spirit lamp is now being consumed, not in making the ether any warmer, but in converting it into vapor, and if I desired to catch this vapor and condense it (as I could without much difficulty), I would have to do the same as if I wished to convert steam into water and water into ice; in either case it would be neces-

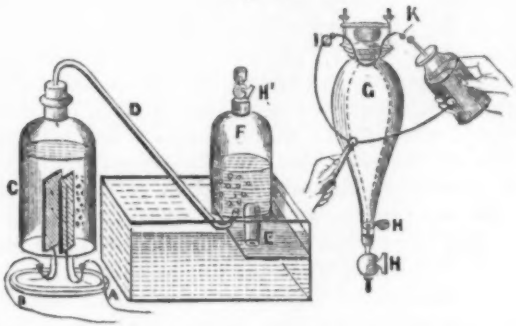
sary to increase the attraction of the particles, by cold or otherwise. So largely is the bulk occupied by the particles increased by giving them this diminished attraction, that if I were to take a portion of water a cubic inch in bulk (A Fig. 3) I should produce a volume of steam of that size B [1700 cubic inches; nearly a cubic foot], so greatly is the attraction of cohesion diminished by heat; and yet it still remains water. You can easily imagine the consequences which are due to this change in volume by heat—the mighty powers of steam and the tremendous explosions which are sometimes produced by this force of water. I want you now to see another experiment which will perhaps give you a better illustration of the bulk occupied by a body when in the state of vapor. Here is a substance which we call iodine, and I am about to submit this solid body to the same kind of condition as regards heat that I did the water and the ether [putting a few grains of iodine into a hot glass globe, which immediately became filled with the violet vapor], and you see the same kind of change produced. Moreover, it gives us the opportunity of observing how beautiful is the violet-colored vapor from this black substance, or rather the mixture of the vapor with air (for I would not wish you to understand that this globe is entirely filled with the vapor of iodine).

If I had taken mercury and converted it into vapor (as I could easily do), I should have a perfectly colorless vapor, for you must understand this about vapors, that bodies in what we call the vaporous or gaseous state, are always perfectly transparent, never cloudy or smoky; they are, however, often colored, and we can frequently have colored vapors or gases produced by colorless particles themselves mixing together, as in this case [the Lecturer here inverted a glass cylinder full of binoxide of nitrogen over a cylinder of oxygen, when the dark red vapor of hyponitric acid was produced]. Here also you see a very excellent illustration of the effect of some power of nature which we have not yet come to, but which stands next on our list—CHEMICAL AFFINITY. And thus you see we can have a violet vapor or an orange vapor, and different other kinds of vapor, but they are always perfectly transparent, or else they would cease to be vapors.

I am now going to lead you a step beyond this consideration of the attraction of the particles for each other. You see we have come to understand that (to take water as an illustration) whether it be ice, or water, or steam, it is always to be considered by us as water. Well, now prepare your minds to go a little deeper into the subject. We have means of searching into the constitution of water beyond any that are afforded us by the action of heat, and among these one of the most important is that force which we call voltaic electricity, which we used at our last meeting for the purpose of obtaining light, and which we carried about the room by means of these wires. This force is produced by the battery behind me, to which, however, I will not now refer more particularly; before we have done we shall know more about this battery, but it must grow up in our knowledge. Now here (Fig. 4) is a portion of water in this little vessel C, and besides the water there are two plates of the metal platinum, which are connected with

the wires A B, coming outside, and I want to examine that water, and the state and the condition in which its particles are arranged. If I were to apply heat to it you know what we should get, it would assume

Fig. 4.



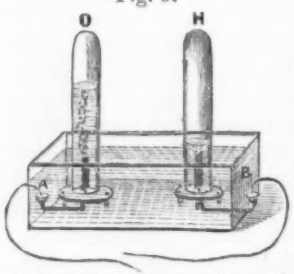
the state of vapor, but it would nevertheless remain water, and would return to the liquid state as soon as the heat was removed. Now by means of these wires (which are connected with the battery behind me, and come under the floor and up through the table) we shall have a certain amount of this new power at our disposal. Here you see it is [causing the ends of the wires to touch]—that is the electric light we used yesterday, and by means of these wires we can cause water to submit itself to this power; for the moment I put them into metallic connexion at A and B, you see the water boiling in that little vessel C, and you hear the bubbling of the gas that is going through the tube D. See how I am converting the water into vapor, and if I take a little vessel E, and fill it with water, and put it in the trough over the end of the tube D, there goes the vapor ascending into the vessel. And yet that is not steam, for you know that if steam is brought near cold water, it would at once condense, and return back again to water; this, then, cannot be steam, for it is bubbling through the cold water in this trough, but it is a vaporous substance, and we must therefore examine it carefully, to see in what way the water has been changed. And now, in order to give you a proof that it is not steam, I am going to show you that it is combustible, for if I take this small vessel to a light, the vapor inside explodes in a manner that steam could never do.

I will now fill this large bell-jar F with water; and I propose letting the gas ascend into it, and I will then show you that we can reproduce the water back again from the vapor or air that is there. Here is a strong glass vessel G, and into it we will let the gas from F pass. We will then fire it by the electric spark, and then after the explosion you will find that we have got the water back again; it will not be much, however, for you will recollect that I showed you how small a portion of water produced a very large volume of vapor. Mr. Anderson will now pump all the air out of this vessel G, and when I have screwed it on to the top of our jar of gas F, you will see upon opening the stop-cocks H′ H H, the water will jump up, showing that some of the gas has

passed into the glass vessel. I will now shut these stop-cocks, and we shall be able to send the electric spark through the gas by means of the wires IK in the upper part of the vessel, and you will see it burn with a most intense flash. [Mr. Anderson here brought a Leyden jar, which he discharged through the confined gas by means of the wires IK.] You saw the flash, and now, that you may see that there is no longer any gas remaining, if I place it over the jar and open the stop-cocks again, up will go the gas, and we can have a second combustion; and so I might go on again and again, and I should continue to accumulate more and more of the water to which the gas has returned. Now is not this curious;—in this vessel C we can go on making from water a large bulk of *permanent gas*, as we call it, and then we can reconvert it into water in this way. [Mr. Anderson brought in another Leyden jar, which, however, from some cause would not ignite the gas. It was therefore recharged, when the explosion took place in the desired manner.] How beautifully we get our results when we are right in our proceedings!—it is not that Nature is wrong when we make a mistake. Now I will lay this vessel G down by my right hand, and you can examine it by-and-by; there is not very much water flowing down, but there is quite sufficient for you to see.

Another wonderful thing about this mode of changing the condition of the water is this—that we are able to get the separate parts of which it is composed, at a distance the one from the other, and to examine them, and see what they are like, and how many of them there are; and for this purpose I have here some more water in a slightly different apparatus to the former one (Fig. 5), and if I place this in connexion with the wires of the battery at AB, I shall get a similar decomposition of the water at the two platinum plates. Now I will put this little tube O over there, and that will collect the gas together that comes from the side A, and this tube H will collect the gas that comes from the other side B, and I think we shall soon be able to see a difference. In this apparatus the wires are a good way apart from each other, and it now seems that *each* of them is capable of drawing off particles from the water and sending them off, and you see that one set of particles, H, is coming off twice as fast as those collected in the other tube O. Something is coming out of the water *there* at H which burns [setting fire to the gas], but what comes out of the water *here* at O, although it will not burn, will support combustion very vigorously [the Lecturer here placed a match with a glowing tip in the gas, when it immediately rekindled].

Fig. 5.

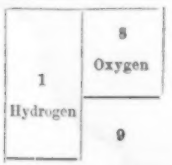


Here, then, we have two things, neither of them being water alone, but which we get out of the water. Water is therefore composed of two substances different to itself, which appear at separate places when it is made to submit to the force which I have in these wires, and if I take an inverted tube of water and collect this gas, H, you will

see that it is by no means the same as the one we collected in the former apparatus (Fig. 4). That exploded with a loud noise when it was lighted, but this will burn quite noiselessly—it is called *hydrogen;* and the other we call *oxygen*—that gas which so beautifully brightens up all combustion but does not burn of itself. So now we see that water consists of two kinds of particles attracting each other in a very different manner to the attraction of gravitation or cohesion, and this new attraction we call *chemical affinity*, or the force of chemical action between different bodies; we are now no longer concerned with the attraction of iron for iron, water for water, wood for wood, or like bodies for each other, as we were when dealing with the force of cohesion; we are dealing with another kind of attraction,—the attraction between particles of a *different* nature one to the other. Chemical affinity depends entirely upon the energy with which particles of *different* kinds attract each other. Oxygen and hydrogen are particles of different kinds, and it is their attraction to each other which makes them chemically combine and produce water.

I must now show you a little more at large what chemical affinity is. I can prepare these gases from other substances as well as from water; and we will now prepare some oxygen: here is another substance which contains oxygen—chlorate of potash; I will put some of it into this glass retort, and Mr. Anderson will apply heat to it; we have here different jars filled with water, and when by the application of heat the chlorate of potash is decomposed, we will displace the water, and fill the jars with gas.

Now when water is opened out in this way by means of the battery; which adds nothing to it materially, which takes nothing from it materially (I mean no *matter*, I am not speaking of *force*), which adds no *matter* to the water; it is changed in this way—the gas which you saw burning a little while ago, called *hydrogen*, is evolved in large quantity, and the other gas, *oxygen*, is evolved in only half the quantity,



Oxygen, . . .	88·9
Hydrogen, . . .	11·1
Water, . . .	100·0

so that those two areas represent water, and those are always the proportions between the two gases. But oxygen is sixteen times the weight of the other—eight times as heavy as the particles of hydrogen in the water; and you therefore know that water is composed of nine parts by weight—one of hydrogen and eight of oxygen, thus:

Hydrogen, . .	46·2 cub. ins. . .	=1 grain.
Oxygen, . .	23·1 " .	=8 "
Water, . (*steam*)	69·3 " . .	=9 "

Now Mr. Anderson has prepared some oxygen, and we will proceed to examine what is the character of this gas. First of all, you remember I told you that it does not burn, but that it affects the burning of

other bodies. I will just set fire to the point of this little bit of wood, and then plunge it into the jar of oxygen, and you will see what this gas does in increasing the brilliancy of the combustion. It does not burn, it does not take fire as the hydrogen would, but how vividly the combustion of the match goes on. Again, if I were to take this wax taper and light it, and turn it upside down in the air, it would, in all probability put itself out, owing to the wax running down into the wick [the Lecturer here turned the lighted taper upside down, when in a few seconds it went out]. Now that will not happen in oxygen gas; you will see how differently it acts (Fig. 6) [the taper was again lighted, turned upside down, and then introduced into a jar of oxygen]. Look at that! see how the very wax itself burns, and falls down in a dazzling stream of fire, so powerfully does the oxygen support combustion. Again, here is another experiment which will serve to illustrate the force, if I may so call it, of oxygen. I have here a circular flame of spirit of wine, and with it I am about to show you the way in which iron burns, because it will serve very well as a comparison between the effect produced by air and oxygen. If I take this ring flame, I can shake, by means of a sieve, the fine particles of iron filings through it, and you will see the way in which they burn [the Lecturer here shook through the flame some iron filings, which took fire and fell through with beautiful scintillations]. But if I now hold the flame over a jar of oxygen [the experiment was repeated over a jar of oxygen, when the combustion of the filings as they fell into the oxygen became almost insupportably brilliant], you see how wonderfully different the effect is in the jar, because there we have oxygen instead of common air.

Fig. 6.

(To be Continued.)

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*On the Influence of White Light, of the different Colored Rays, and of Darkness, on the Development, Growth, and Nutrition of Animals.** By Horace Dobell, M. D., &c.

The apparatus used in the following experiments was described in my Paper; but in the present instance, only two of the cells were employed, viz: that exposed to ordinary white light, and that from which all light is excluded. In order more effectually to prevent the possible admission of light, the following precautions were adopted with the dark cell:—1. The perforated zinc floor was covered with thick brown paper. 2. The under surface of the lid was lined with black cloth, to secure accurate adjustment when shut. 3. The opaque black glass was covered with an additional coat of black oil-paint. 4. The lid was never opened in any light except that of a candle or of gas.

March 20th, 1859.—A number of ova of the silk-worm (*Bombyx mori*), all of the same age, were placed in each of the two cells. No

* From the Lond. Ed. and Dub. Phil. Mag., June, 1860.

change was observed until *May* 18*th* (sixty days after the commencement of the experiments), when one larva emerged from the ovum in each cell; and during twelve days, larvæ continued to emerge in the light and in the dark at the same rate.

June 9*th*.—Sixteen larvæ, as nearly as possible of the same size, were selected in each cell, and the rest removed. The experiments then proceeded with these thirty-two individuals, and no death occurred from first to last.

The following Table shows the day on which each larva began to spin; the day on which the perfect insect escaped from the pupa; and hence the number of days occupied by the metamorphosis.

Light.			Darkness.		
Day of beginning to spin.	Day of escape of the Moth.	Number of days occupied by metamorphosis.	Day of beginning to spin.	Day of escape of the Moth.	Number of days occupied by metamorphosis.
July 1	July 18	18 days inclusive	June 30	July 18	19 days inclusive.
" 2	" 19	18 " "	" 30	" 18	19 " "
" 2	" 19	18 " "	" 30	" 18	19 " "
" 2	" 18	17 " "	" 30	" 18	19 " "
" 2	" 18	17 " "	" 30	" 21	22 " "
" 2	" 19	18 " "	July 1	" 18	18 " "
" 2	" 19	18 " "	" 1	" 18	18 " "
" 3	" 19	17 " "	" 2	" 18	17 " "
" 3	" 21	19 " "	" 2	" 19	18 " "
" 4	" 20	17 " "	" 2	" 20	19 " "
" 4	" 20	17 " "	" 2	" 19	18 " "
" 4	" 20	17 " "	" 2	" 20	19 " "
" 4	" 21	18 " "	" 2	" 21	20 " "
" 4	" 21	18 " "	" 3	" 21	19 " "
" 5	" 21	17 " "	" 3	" 20	18 " "
" 6	" 24	19 " "	" 4	" 21	18 " "

From this it is seen that the mean period occupied by the metamorphosis in the *darkened cell* was eighteen days fifteen hours, and in the *light cell* seventeen days sixteen hours.

The longest and shortest periods in the *darkened cell*, twenty-two days and seventeen days, in the *light cell*, nineteen days and seventeen days.

June 9*th*.—On selection of sixteen of the largest larvæ from the inhabitants of each cell, it was noted that, when sixteen were selected from the *darkened cell* and several of *similar size* removed, only four could be found as large in the *white cell;* the remaining twelve selected were therefore of a rather smaller size. This difference in the two cells became less obvious afterwards, but, throughout the experiments, there was a slight difference of size in favor of the darkened cell.

With these exceptions, no difference could be detected between the results obtained in the cell from which light was completely excluded and in that exposed to its full influence.

The larvæ, the silk produced, and the moths from the two cells, when placed side by side, could not be distinguished from one another.

The ova were of the same color when first deposited, and under-

went the same changes of appearance, at the same time, in the dark and in the light.

So far, therefore, as the direct agency of light is concerned in the development, growth, nutrition, and coloration of animals, the results of these experiments closely correspond with those already recorded in my Paper.—*Phil. Mag.* s. 4. vol. xviii, p. 143.

For the Journal of the Franklin Institute.

Observations on the Eclipse of July 17th, 1860.

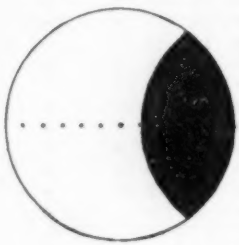
The following observations of the eclipse of the sun, July 17, 1860, were made at Germantown, Penna. Lat. of observatory, 40° 1′ 39″, Long. 5° 0′ 41·9″.

The instrument used was a good refractor, and the time is that shown by an astronomical clock regulated by a transit instrument.

The morning was clear, and in every respect favorable to observation.

Time of first contact,	19h	5m	00s	Thermom. in sun,	96°
Greatest obscuration,	20	4	18·5	" "	89
End of eclipse,	21	3	37	" "	106·5

The mean height of the thermometer in the sun during the eclipse, was 101·25°, which point, it is fair to suppose, it would have reached at 20 h. 4 m. 18·5 s. under ordinary circumstances, and therefore that a modification of temperature of 12·25° was produced by the interception of the sun's rays at the middle of the eclipse.



The figure, which is taken from a drawing of the image thrown upon the ground glass of a camera obscura at the time of greatest obscuration, shows five digits eclipsed.

N. B. It may not be amiss in this connexion to make some allusion to the very extraordinary atmospheric phenomenon of Friday evening, the 20th inst.

About 9½ o'clock, P. M., a luminous body nearly the size of the full moon when setting, appeared in the western heavens, at an elevation of about 25°, shedding a brilliant light upon all terrestrial objects. It moved with moderate velocity in a north-easterly direction, preserving its parallelism with the horizon almost throughout its course, upon reaching the centre of which it divided, without any perceptible report however, into several lesser bodies, following each other at short intervals, gradually diminishing and leaving sparks in their train, until lost in the east in one single bright star, about the diameter of the planet Mars, as it now appears.

It is not a little remarkable that, notwithstanding the large number of persons who witnessed this phenomenon, singular coincidence prevailed in their impressions with regard to its magnitude, velocity, duration, &c.: thus contradicting the common assertion that no two men see the same thing alike. W.

Germantown.

*Description of a Patent Blast Gas Furnace.** By J. J. Griffin, F.C.S.

(Continued from page 101.)

Gas Furnace heated at the bottom.—In this furnace the parts are the same as those marked *a*, *b*, *c*, *d*, *e*, *e*, in Fig. 2; but the gas-burner is in this case put into the bottom of the furnace instead of the top, and the arrangement of the crucible and its support is altered. Upon the centre of the clay plate *d*, the perforated plumbago cylinder and cover, Nos. 5 and 7 are placed; and upon them a plumbago crucible, No. 10. The size of the crucible, and the height of the perforated cylinder, are to be so adjusted that the bottom of the crucible shall be struck by the hottest part of the gas flame; that is to say, the space left between the face of the gas-burner and the bottom of the crucible must not exceed 2½ inches. The crucible is provided with a closely fitting cover, and pebbles are then filled in between the crucible jacket and the furnace cylinder, and are covered over the crucible until both the pieces of the furnace *e e*, are filled. The gas is then lighted, the blast of air is set on, the gas-burner is forced up into the hole in the clay plate *d*, and the operation proceeds. In from ten to twenty minutes after the gas is lighted—this difference of time depending upon the size of the furnace, and the weight of the metal contained in the crucible—the interior of the lower cylinder *e*, acquires a white heat. The progress of the operation can be watched by occasionally removing the stone peg in the trial-hole of the furnace cylinder *e*. The heat very slowly ascends into the upper cylinder, and it never becomes so great in the upper as in the lower cylinder. The greatest fusing power of the furnace is confined within a vertical space of about six inches, reckoning from the bottom. The power of flint pebbles to abstract heat from the gases which pass through this apparatus is quite remarkable. When about six inches of pebbles lie above the crucible, and the crucible and the pebbles about it have been white hot for half an hour, the hand can be held over the top of the furnace, within a few inches of the pebbles, without inconvenience. It becomes wetted with the vapor which rises from the furnace, but feels only a moderate degree of heat.

This form of the furnace is attended by the inconvenience that you cannot examine the condition of the matter contained in the crucible, to ascertain when the heat has been continued long enough. In cases where the fusion is performed repeatedly on the same weight of metal, this would be of no importance, because the power of the furnace is so steady and regular, that the time of firing which has been found to answer once will answer the same purpose again.

When it is supposed that the fusion of the metal submitted to trial is completed, the gas is first to be turned off, and then the supply of air stopped. You can either allow the furnace to remain intact till it is cold, or lift off the cylinders *e e*, with tongs, and allow the hot stones to fall into the iron pan placed below the furnace to receive them. A

* From the Lond. Chemical News, No. 4.

few bricks should be laid between the pan and the table or stool on which it rests, if the latter is made of wood; because the heat given off by the pebbles is very great. The pebbles being raked away from the crucible, the contents of the latter can be examined.

The absolute sizes of the furnaces depend upon the amount of work required from them. The fusions described below were mostly made in a furnace of six inches internal diameter, a few in a furnace of four inches internal diameter, and one or two in a furnace of eight inches internal diameter; all of them with a gas-burner of sixteen holes, and a supply of gas obtained from a half-inch pipe. A large furnace with an internal diameter of twelve inches, will demand a gas-burner of twenty-six holes, and a supply of gas from a pipe of nearly one inch in the bore.

Examples of Fusions effected by the Blast Gas Furnace.—The fusing points of certain metals have been fixed by Daniell at the following temperatures:—

Silver, . .	1873° F.	Copper, . .	1996° F.
Gold, . . .	2016°	Cast Iron, . .	2786°

Brass, with 25 per cent. of zinc, at 1750° F.

All these metals melt readily in the gas furnace. Quantities of 3 lbs. of copper or cast iron can be completely fused in fifteen minutes in a six-inch furnace. Quantities of 8 or 10 lbs. of copper or cast iron can be completely fused into a homogeneous mass in a six-inch or eight-inch furnace within one hour, using a sixteen-hole burner, and a supply of gas from a half-inch pipe.

In a furnace of the same size I have fused 45 ounces of nickel, and in other experiments I have produced masses of wrought iron weighing 18 ounces, 28 ounces, 40 ounces. The piece of 18 ounces was perfectly fused. The piece of 30 ounces was not quite fused, the crucible having melted, and stopped the operation. I have also fused cobalt, and reduced it to the metallic state from the peroxide by ignition with charcoal. The time required for the fusion of these refractory metals is from one and a half to two hours.

Scraps of platinum can be fused into a porous mass, but not into a solid homogeneous bead. I have mentioned that thin platinum wires fuse readily in the free flame of the gas-jet produced by the burner (Fig. 1); but when the jet plays upon a quantity of the metal contained in a crucible the relations of power and effect are different.

When the metals to be melted are such as do not undergo oxidation, the method of action represented by Fig. 2 is most convenient. In this manner gold can be readily melted, and by removing the gas-burner the melted metal can be stirred. When the action of oxygen is to be avoided, the crucible must have a cover, which in some cases should be securely luted to it.

Choice of Crucibles.—The experiments above referred to were made with coal gas at the ordinary pressure, and with a blast of cold atmospheric air. Greater effects can be produced by the use of oxygen gas, or of heated atmospheric air. But a difficulty stands in the way of the use of these greater degrees of heat in the want of crucibles capable of enduring their action.

With cold atmospheric air, pure nickel and pure iron dissolve every kind of siliceous crucible, and it is, therefore, needless to heat the air or to prepare oxygen till a superior kind of crucible is obtainable. At present, these metals can only be melted in plumbago crucibles, which necessarily communicate to them more or less carbon.

Metals which melt at moderate degrees of heat, such as gold and copper, are easily fused either in clay crucibles, or in those of plumbago; the latter, be it remembered, being a mixture of graphite and clay. Metals in combination with carbon, such as cast iron, also melt readily in clay crucibles, without destroying them. But when such metals as iron, nickel, and cobalt, are freed from carbon, and brought into a state of purity, they acquire an extraordinary attraction for silica at a white heat, so that the metal and the silica readily run down into a very fusible silicate. Even when plumbago crucibles are used, the carbon burns away at some particular point, the metal then attacks the clay, bores a hole through the crucible, and finishes the operation. No kind of clay or porcelain will withstand the action of pure iron or nickel at a white heat. It is therefore impossible to effect any large fusions of these metals when they are free from carbon, or when they are heated in crucibles that are free from carbon.

Fusion of Metals in large quantities, and Ignition of Objects of large size.—As the gas-burner, Fig. 1, can be held in any required position, it is possible to apply heat to large objects by using several gas-burners. Thus, a large crucible may be fixed in a square furnace, and gas-burners be applied below and on the four sides of the furnace; the spaces between the crucible and the walls of the furnace being filled with pebbles, to collect the heat and apply it to all parts of the crucible.

Muffle Furnace for Assaying, Roasting, &c.—A muffle, placed in an assay furnace, and built up with pebbles, can be heated either from above or from below by the blast gas-burner. The flame and products of combustion can be made to sweep through the muffle, whether going upwards or downwards. The *air* pipe and *gas* pipe attached to the gas-burner, Fig. 1, must each be provided with a stop-cock. When the front door of the muffle is opened to afford the opportunity for examining the cupels, the blast, if continued, would blow out there against the operator; but that occurrence is prevented by turning the stop-cocks. When it is desired to oxidize the substances in the muffle, the furnace is first brought up to a sufficient temperature, and then the gas is turned off, but the blast of air is continued. The air passing through the hot pebbles enters the muffle at a high temperature, and not exhausted of oxygen, because there is no carbonaceous matter present among the pebbles when the gas is turned off. The pure and highly heated air is consequently in a proper condition for oxidizing metals that are already raised to a red heat in the muffle. The same apparatus is useful where substances require to be roasted in the presence of air, in order to oxidize and expel some volatile ingredient. We have in this process an effectual means of using hot air to aid the process of cupellation.

Distillation per Descensum.—Suppose a stoneware bottle with a long neck to be fitted with a stoneware tube, passing nearly to the bottom of the bottle, and projecting some inches beyond its mouth. Suppose this bottle to be half filled with metallic zinc, and then to be fixed upside down in the furnace, Fig. 2, with the tube projecting downwards through the hole in the plate *d*, and nearly dipping into a vessel of water. The furnace being packed with pebbles, and the heat applied at the top, the distillation of zinc *per descensum* then takes place.

Miscellaneous Uses of the Blast Gas Furnace.—1. The preparation of chemical substances by the projection of mixtures into a crucible kept at a red or a white heat. 2. For melting silver, gold, copper, cast iron, brass, bronze, nickel-silver, &c., either for making small castings or ingots. 3. For experiments on glass; every description of which it is able to fuse. 4. For experiments on enamel, colored glasses, and artificial gems. 5. For experiments on metallic alloys. 6. For the fusion of steel. 7. For the use of dentists, in the preparation of mineral artificial teeth. 8. For the assay of ores of silver, copper, lead, tin, iron, and other metals. 9. For all purposes of ignition, combustion, fusion, or dry distillation, at a red heat, or a white heat, where it is desirable to produce those temperatures promptly, certainly, steadily, conveniently, and cheaply.

Exhibition of Colored Flames.—When the gas-burner, Fig. 1, is supplied with gas and air, and is inflamed in the open air, so as to produce a clear blue flame of 3 inches long, and beyond it a flickering, nearly colorless flame of 12 inches long, brilliant colors may be given to this flame by the introduction of concentrated solutions of certain salts. A ball of pumice-stone, 2 inches in diameter, fastened to a stout iron wire, is dipped into the saline solution, and while wet is plunged into the flame, upon which the whole flame becomes colored. Solutions of the following salts may be used for these experiments:—

1. *Chloride of Strontium* gives a brilliant crimson flame. 2. *Chloride of Calcium*, a reddish orange flame. 3. *Chloride of Sodium*, brilliant yellow. 4. *Chloride of Copper*, blueish green. If the flame is touched on one side with the copper solution, and on the other with the strontium solution, half the flame is green and half crimson. The colors and reflections of these flames are necessarily most brilliant in a dark room. A remarkable effect is produced by the yellow soda flame. It is reflected from the human countenance with a ghastly blackness.

Repair of the Gas Furnace.—When the clay cylinders become warped or chipped, so as to allow the gases to escape at the joints laterally, they must be luted for each operation by applying a little wet fire-clay by means of a spatula. When only a moderate heat is required, this luting is unnecessary.

The Patent Blast Gas Furnace is capable of melting so many of the refractory metals, and in quantities that are so well adapted for the usual analytical experiments of chemists and assayers, as almost to supersed the use of fixed wind furnaces and portable blast furnaces, fed by charcoal or coke.

For the Journal of the Franklin Institute.

Notes on the Evaporative Efficiency of "Japanese Coals" for Steaming Purposes. By Wm. H. Shock, Chief Engineer U. S. Navy.

In obedience to an order of the late Commander-in-chief of the East India Squadron to furnish him with a statement of the comparative value of the Japanese coals for steaming purposes with that of other coals used in the Navy, I availed myself for this purpose of copies of the steam logs and engine diagrams of the frigates *Minnesota* and *Mississippi*, which were kindly furnished by their respective chief engineers, for the period in which they used the coals; and with the data in my own possession of the *Powhatan* whilst using the same coals, the following record of results was deduced:

It is proper to state that the coals were received on board the ships and expended in the usual manner, without any reference whatever to a special report. This fact establishes the *practical* value of the results.

Particulars of the Ships.—The *Minnesota* is a screw frigate 3200 tons. Two trunk engines, direct-acting. Working area of each piston, 4071·5 sq. ins. Stroke of pistons, 36 ins. Supplied by 4 multitubular boilers, Martin's patent. Heating surface, 11,500 sq. ft. Space displacement of piston for one revolution of one engine, 169·60 cubic feet. Space included in nozzles, clearance, &c., at both ends of one cylinder, 9·90 cubic feet. Total capacity for steam in one engine for one revolution, 179·50 cubic feet.

The *Mississippi* is a side-wheel steamer of the first class, 1692 tons. Two side-lever engines. Diameter of cylinder, 75·5 ins. Stroke of piston, 7 ft. Supplied with 2 multitubular boilers, Martin's patent. Heating surface, 7676 sq. feet. Space displacement of piston for one revolution of one engine, 435·20 cubic feet. Space included in nozzles, clearance, &c., at both ends of one cylinder, 21·52 cubic feet. Total capacity for steam in one engine for one revolution, 456·72 cub. ft.

The *Powhatan* is a side-wheel steamer of the first class, 2415 tons. Two inclined engines. Diameter of cylinder, 70 ins. Stroke of piston, 10 ft. Supplied with 4 copper boilers, double upper return flues. Heating surface, 8100·59 sq. ft. Space displacement of piston for one revolution of one engine, 534·50 cub. ft. Space included in nozzles, clearance, &c., at both ends of one cylinder, 26·00 cub. ft. Total capacity for steam in one engine for one revolution, 560·50 cub. ft.

Localities of the Mines and their mode of working them.—There are without doubt vast coal fields interspersed throughout the Japanese Empire, unknown even to the Japanese themselves. But of those known and worked, I have examined specimens from three, viz:—From one near Hakodadi on the island of Yesso, in the northern part of Japan; a second from Sikuzen on the island of Kiusiu (110 miles from Nagasaki); and the third from a mine in the province Satzuma, near Nagasaki: all presenting nearly the same characteristics.

I have never been permitted at any time to visit the mines. They

persistently objected to foreigners inspecting them; but from the most reliable authority I learned that they are worked without the aid of machinery, both coal and water being brought out on the backs of coolies in buckets; and the working of an opening is quickly suspended when the labor necessary to keep down the water exceeds that required to bring away the coals, which soon occurs after getting below the surface, particularly in a country abounding in springs, as does Japan. The result is that old openings are abandoned before they are worked sufficiently deep to secure good coals, and hence it rarely if ever occurs that any but outcroppings and surface coals reach market.

Description of the Coals.—Their Furnace Phenomena.—The coals are bituminous. Cohesion weak. Mechanical structure, lamellar. Fractures exhibit a dull black in all their partings. 37 cub. ft. displace one ton. In the furnace it kindles easily and burns freely with a bright flame, emitting immense volumes of densely black smoke. Intumesces slightly, and occasionally I found traces of iron pyrites present in minute quantities.

Residuum—Large quantities of spongy clinker (from 27 to 30 per cent. by weight) which cake on the bars but are readily removed. The per centum of clinker by *weight* conveys no idea of its *bulk*, as it must have reached in many cases the enormous proportion of 50 per cent.! The proportion of ashes produced was unusually small.

Data and Results deduced therefrom.

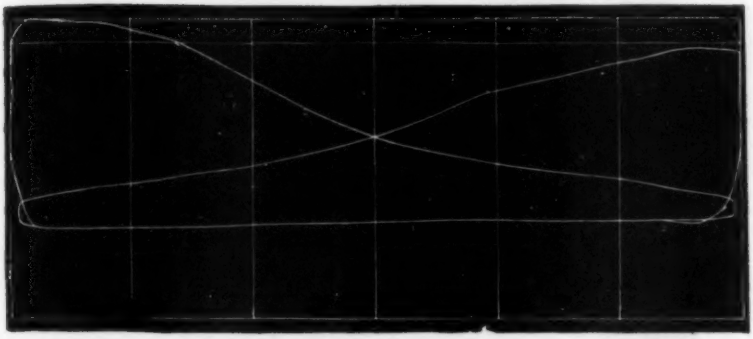
Copy MINNESOTA'S *Steam Log.* CAPT. S. F. DUPONT *Commanding. At sea, September 1st*, 1858.

Hour. A.M.	Speed. K.	Speed. F.	Course.	Wind. Direc.	Wind. Force.	Revolution of Engine.	Pressure of Steam.	Vacuum. A.	Vacuum. F.	Throttle.	Coal	Ashes.	Sat. of Boilers. 1	2	3	4	Temperature Engine Room.	Hot-well. A.	Hot-well. F.	Mean Terminal Pressure of the Day's Diagrams. 6th Int.
1	7	4	W S W.	SE by S.	4	33·1	7	19	23	¾	3640		1½	2	1½	1¾	106	104	104	
2	7	4	"	S.	4	31·6	5	19	22	¾	4200		1½	1¾	1½	1¾	104	102	102	
3	9	4	W by S.	"	4	35·1	8	19	22	¾	5740		1½	1¾	1½	1¾	104	102	102	
4	10	4	"	"	5	36·5	12	20	22	¾	6440	13520	1¾	1¾	1½	1½	104	104	104	
5	8	4	W S W.	S. by E.	5	26·5	12	19	21	⅞	2520		1¾	1⅞	1¾	1¾	106	98	97	
6	7	4	W by S.	"	5	29·8	8	19½	22	1	4760		1¾	1⅞	1¾	1¾	106	98	97	
7	7	4	"	"	4	31·6	10	20	22	⅞	2240		1¾	1¾	1¾	1¾	106	98	97	
8	7	2	"	S S E.	4	33·7	11	20½	22	¾	6020	9048	1	1⅞	1¾	1¾	106	100	100	
9	8	2	"	"	4	33·6	9	19½	22	¾	3080		1¾	1¾	1¾	1¾	106	98	98	
10	7	4	"	"	3	32·1	7	19½	22	¾	2800		1¾	1¾	1¾	1¾	101	97	97	
11	7	2	"	"	3	31·	6	19½	22	¾	3920		1¾	1¾	1¾	1¾	101	97	97	
12	7	6	"	E.	4	39·5	10	19½	22	¾	7000	10408	1¾	1⅞	1¾	1¾	101	97	97	
	Expended, 105,000 Japan Coals.										Revolutions made, 48,865.						Knots run, 189·4			
P.M.																				
1	10	4	W ½ S.	N E.	4	39·	10	25½	24	¾	3640		1¾	1⅞	1¾	1¾	101	98	99	
2	11	6	"	N.	5	39·	10	23	23	¾	3220		1⅞	1¾	1¾	1¾	102	96	98	
3	5–4	6	W by S.	N by W.	6	40·	13	25½	23	¾	7980		1¾	1¾	1¾	1½	102	98	100	
4	4–6		"	"	10	33·	9	25½	23	¾	4900	5750	1¾	1¾	1¾	1½	102	98	100	
5	7	4	"	"	9	33·1	10	24½	22½	⅞	4060		1¾	1⅞	1¾	1¾	105	98	101	
6	7	4	W.	"	8	29·3	8	24	22½	⅞	3360		1¾	1¾	1¾	1⅞	105	98	101	
7	6	4	"	"	6	33·9	12	24	23	⅞	4620		1⅞	1¾	1¾	1¾	98	95	95	
8	6	4	"	"	6	33·3	10	24½	23	⅞	7000	13312	1¾	1¾	1¾	1¾	98	95	97	
9	5	4	"	"	7	31·5	9	24½	23	⅞	3500		1½	1¾	1¾	1⅞	94	94	95	
10	5	4	"	"	7	28·8	7	24	23½	1	3500		1½	1¾	1¾	1⅞	94	95	95	
11	5	4	"	N N W.	7	34·6	8	24	22½	⅞	3360		1½	1⅞	1¾	1⅞	94	95	95	
12	6	4	W ½ S.	"	8	34·6	8	24	22½	⅞	3500	11232	1½	1⅞	1¾	1⅞	94	95	95	

U. S. S. F. MINNESOTA, Sept. 1st, 1858, 11·10 A. M.

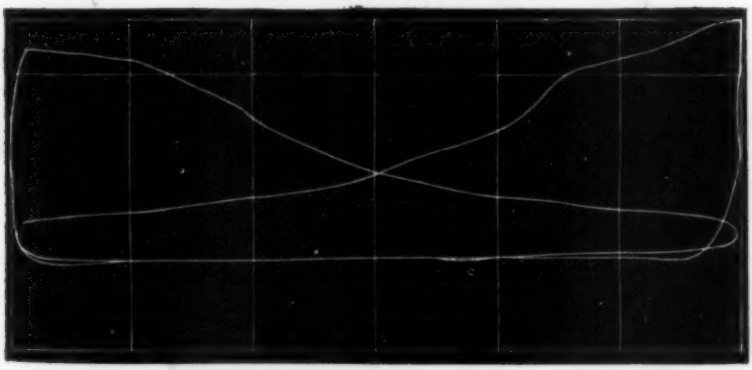
Scale, 1-10th inch = 1 lb.

Steam,	10	Hot-well,	98°
Vacuum,	22½	Throttle,	¾
Revolutions,	34		



U. S. S. F. MINNESOTA, Sept. 1st, 1858.

Steam,	10	Hot-well,	97°
Vacuum,	23	Throttle,	¾
Revolutions,	34		



From the above log and diagrams we get the following data.—

Mean terminal pressure of the four diagrams,	6·718 lbs.
Average coal per hour,	4375 "
" revolutions per minute,	33·9
" temperature of feed-water,	139°
" saturation of boilers,	11-16
" throttle,	¾

From which the following calculation of boiler performance while using Japan coals is made, viz:

$$\frac{179{\cdot}50 \times 33{\cdot}9 \times 2}{3538} = 3{\cdot}439.$$

And

$$\frac{3{\cdot}439 \times 60 \times 64{\cdot}3}{4375} = 3{\cdot}03 \text{ lbs. water.}$$

To this must be added the per centum of useful effect lost in fuel from blowing to maintain the boiler water at a saturation of $\frac{11}{16}$ which in this case was found to be 12, its equivalent in pounds of water evaporated being ·3636. And 3·03 + ·3636 = 3·39 lbs. of water evaporated per pound of coal, was the maximum boiler performance with Japan coals.

By examining the above log, it will be seen that the ashes and clinker for the 24 hours, exceeded the enormous figure of 60 per centum.

Remarks.—Large deposits of soot and ashes collecting on lower tube sheets and around the tubes.

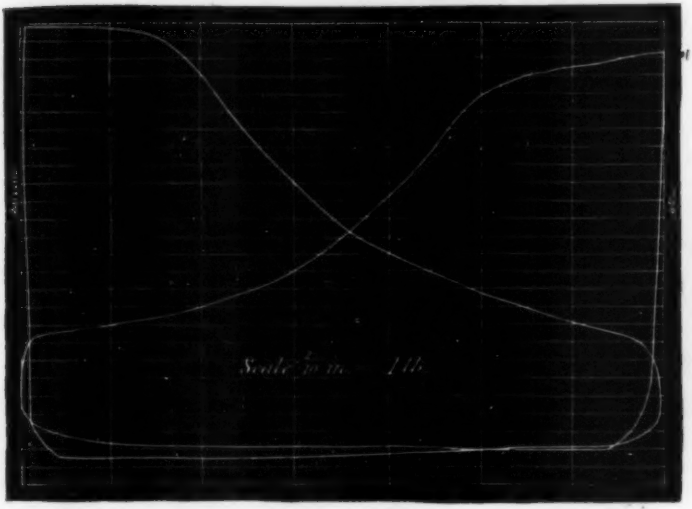
Copy Steam Log of the U. S. Steamer Mississippi. Capt. Wm. C. Nicholson, *Commanding. At sea, August 4th,* 1858.

H. A.M.	Speed. K.	Speed. F.	Course.	Wind. Direc.	Wind. Force.	Revolution of Engine.	Ashes, lbs.	Pressure of Steam.	Vacuum. S.	Vacuum. P.	Throttle.	Coal lbs.	Saturat. of boilers 1	Saturat. of boilers 2	Temperatures Hotwell.	Feedw'r.	Engine Room.	On deck.	Inject. water.
1	8		N b E½E	S W.	2	8·6		7	27·5	27	2	2640	1¾	1¾			96		
2	8	4	"	W.	3	10·1		11	"	"	"	2970	"	"			97	70	72
3	8	4	"	"	3	10·1		11	"	"	"	2970	"	"			97		
4	8	4	"	N W.	2	9·6	4400	11	"	"	"	2860	"	"	96	130	97	70	72
5	7	6	"	"	1	8·8		8	"	"	"	2970	"	"			90		
6	8		N ½ E.	N.	1	9·		9	"	"	"	2970	"	"			80	70	72
7	7	4	"	N by E.	2	8·8		9	"	"	"	2970	"	"			90		
8	7	4	"	"	2	9·1	4200	10	"	"	"	2970	"	"	98	133	92	70	72
9	6	6	"	N N E.	2	8·5		8	"	"	"	2970	"	"			88		
10	7		"	"	2	8·5		8	"	"	"	2860	"	"			88	73	72
11	7		"	"	2	9·1		10	"	"	"	2860	"	"			90		
12	7		"	"	2	9·1		10	"	"	"	2860	"	"	100	135	88	75	72
	Expended, 60,905 Japan coals.							Revolutions made, 13,310.							Knots run, 186·4 per log.				
P.M.																			
1	3	4	N ½ E.																
1	4	2	N by W.	N by E.	2	9·1		10	27·5	27	2	2860	1¾	1¾			90		
2	8		"	N N W.	2	9·3		10	"	"	"	2860	"	"			93	78	73
3	8		"	"	2	9·8		11	"	"	"	2970	"	"			94		
4	5	2	"																
4	2		N.	"	2	8·8	3750	9	"	"	"	2970	"	"	98	130	90	78	73
5	8		"	"	2	9·3		11	"	"	"	2970	"	"			90		
6	4		"																
6	4		N by E.	"	2	10·1		13	"	"	"	2970	"	"			90	77	73
7	8		"	N.	1	10		11	"	"	"	2970	1⅝	"			91		
8	8	2	"	N N E.	1	10	4900	11	"	"	"	2970	"	"	106	142	90	78	73
9	7	6	N E ½ E.	N by E.	1	8·6		8	"	"	"	2860	"	"			90		
10	7	4	"	N N E.	2	8·8		9	"	"	"	2860	1¾	"			90	75	73
11	8		"	"	2	8·8		9	"	"	"	2915	"	"			90		
12	8		"	"	2	9	4150	10	"	"	"	2860	"	"	92	130	87	74	73

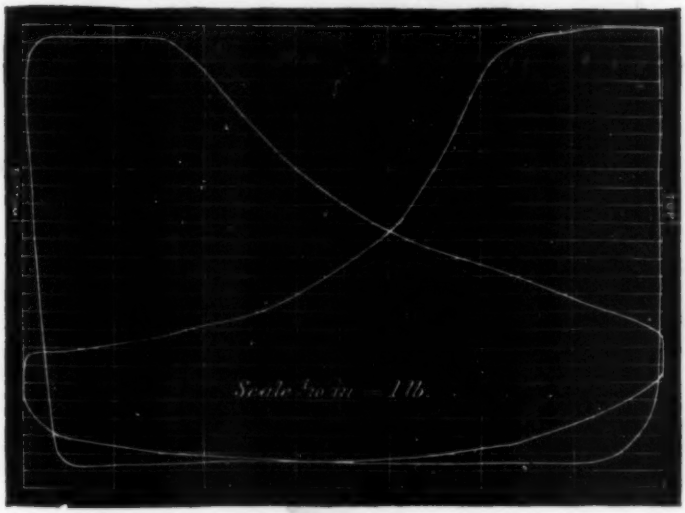
Mean Terminal Pressure of the Day's Diagrams, 8·31 lbs.

PORT ENGINE.

U. S. S. F. Mississippi, Aug. 4th, 1858.



Average steam per gauge, 10 lbs.		Vacuum, . .	26·75
Revolutions, . .	8·55	Throttle, .	2
Lift of steam-valve,	3 ins.		



Average steam per gauge, 10·25 lbs.		Vacuum, . .	27·5
Revolutions, . .	9	Throttle, .	2
Lift of steam-valve, .	3 ins.		

From the above log and diagrams the following calculations of boiler performance while using Japan coals are made, viz :—

Mean terminal pressure of the diagrams,	8·31 lbs.
Average coal per hour,	2912 "
" revolutions per minute,	9·24
" temperature of feed-water,	135°
" saturation of boilers,	1·75
" throttle,	2
" steam per gauge,	9·7 "

$$\frac{456{\cdot}72 \times 9{\cdot}24 \times 2}{2829} = 2{\cdot}983.$$

And $$\frac{2{\cdot}983 \times 60 \times 64{\cdot}3}{2912} = 3{\cdot}95 \text{ lbs. of water.}$$

To this (as in the case of the *Minnesota*) an additional per centum for loss of useful effect in fuel from blowing to maintain the boiler water at a saturation of $\frac{1\frac{3}{4}}{32}$ must be added, which is found to be 11·6, its equivalent in pounds of water evaporated being ·458; and ·458 + 3·95 = 4·408 lbs. of water evaporated per pound of coal, was the maximum boiler performance.

The residuum in clinker and ashes for this day was 36·75 per cent.

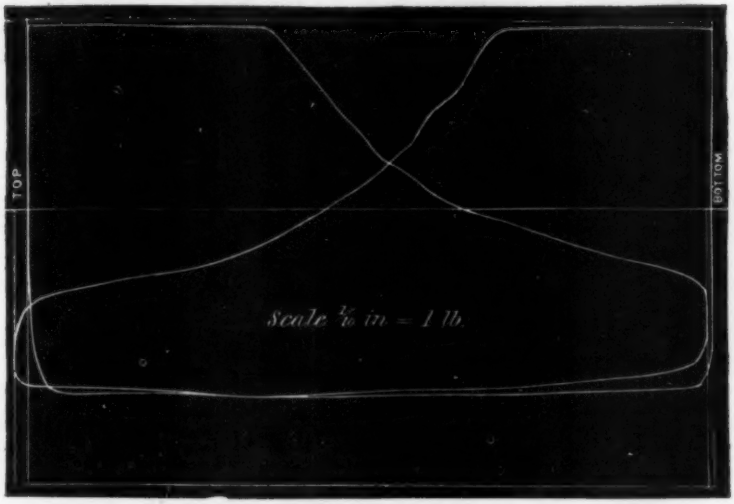
Remarks.—Immense quantities of soot and cinders collecting on the tube sheets and between tubes, rendering it necessary on one occasion to clean them while under way.

Copy Steam Log of the U. S. Steamer POWHATAN, *Flag Ship of Flag Officer Tattnall.*
CAPT. G. F. PEARSON, *Commanding. At sea, July 23d*, 1858.

H. A.M.	Speed. K.	Speed. F.	Course.	Wind. Direc.	Wind. Force.	Revolutions of Engine.	Hot-well.	Pressure of Steam.	Vacuum. S.	Vacuum. P.	Throttle.	Coal lbs.	Sat. of Boilers. 1	2	3	4	Temp. Engine Room.	Temp. On deck.	Ashes, lbs.
1	9		SbW½W.	S by W.	3	9·7	120	10·5	25¼	25¼	8	4367	1⅝	1¾	1⅝	1⅝	106	80	
2	8		"	"	3	9·5	120	10	"	"	"	4291	1¾	"	1¾	"	106	81	
3	7		"																
		4	SbyE½E.	S S W.	3	8·9	115	9·5	"	"	"	4015	"	"	"	"	105	80½	
4	5		"	"	3	8·6	116	9·5	"	"	"	3285	"	"	"	1¾	97	80	3240
5	5		"	SW by S.	4	9·1	116	10	25½	25½	"	3285	"	"	"	"	88	80	
6	5		"																
	2	4	E S E.	"	4	10·7	119	10·5	"	"	"	4974	"	"	"	"	89	80½	
7	4	4	SEbE½E.																
	4	4	E S E.	"	4	11·1	"	10·5	"	"	"	4974	"	"	"	"	88	78	
8	9	4	"	"	4	11·6	"	10	"	"	"	5840	"	"	"	"	92	80	4800
9	9		"	"	4	11·5	"	10	"	"	"	5840	"	1⅝	1⅝	"	90	79	
10	9		"	S W.	4	11·3	"	10·5	"	"	"	4974	"	1¾	1¾	"	93	79	
11	9		"	"	4	11·8	120	10·5	"	"	"	4826	1⅝	1⅝	"	"	94	81	
12	9		E ¼ S.	"	3	11·5	120	10·5	"	"	"	4774	1⅝	1⅝	"	"	96	84	4200
	Expended, 100,886 Japan coals.					Revolutions made, 15,958.							Knots run, 209·4.						
P.M.																			
1	9	4	E N E.	S W.	3	11·5	120	10·5	25½	25½	8	4818	1¾	1¾	1¾	1⅝	94	82½	
2	10		NEbE½E	"	3	12·4	"	10	"	"	"	4774	"	"	"	1⅝	91	81½	
3	9	4	"	S S W.	3	11·5	"	9·5	"	"	"	3870	"	"	"	1¾	89	80	
4	9	4	"	"	3	11·5	"	9·5	"	"	"	3804	"	"	"	"	88	78	3300
5	9		"	"	3	11·5	118	9·5	"	"	"	3792	"	"	"	"	87	78	
6	9	4	"	"	3	11·4	120	9·5	"	"	"	4233	"	"	"	"	90	78	
7	9	4	"	SWbyW.	5	11·4	"	9·5	"	"	"	3870	"	"	"	"	90	79	
8	9	4	"	"	5	11·6	"	10	"	"	"	2430	"	"	"	"	90	79	4620
9	10		"	"	6	11·6	"	9·5	"	"	"	4453	"	1⅝	"	1⅝	92	80	
10	10		"	"	6	11·8	"	9·5	"	"	"	3577	"	"	"	"	91	80	
11	10		"	"	6	11·6	"	9·5	"	"	"	3500	1⅝	"	1⅝	"	91	80	
12	11		"	"	6	11·8	"	9·5	"	"	"	2920	1¾	"	1⅝	"	91	80	2580

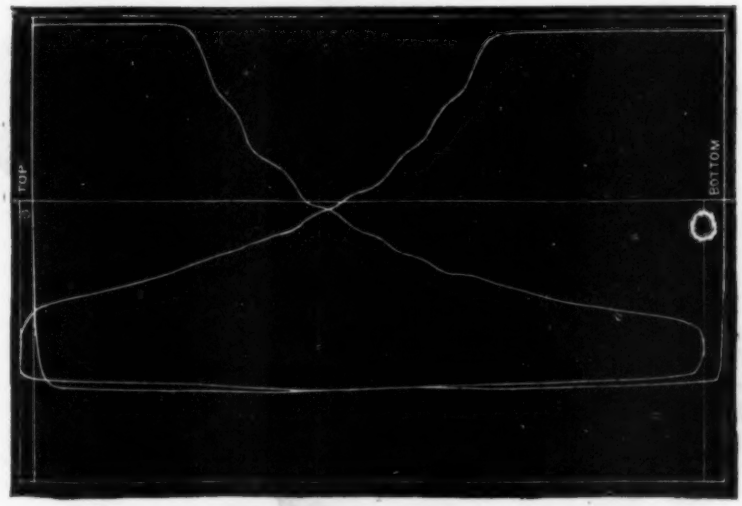
42·9 ins. aver. point cutting off from commencement of stroke, includ. clearance, &c.

U. S. S. F. Powhatan, July 23d, 1858.



Steam,	10·5	Revolutions,	11·4
Vacuum,	25·5	Throttle,	8
Hot-well,	118		

PORT ENGINE.



The following data deduced from the above log is the basis of the calculation for the boiler's performance with the Japan coals.

It will be observed that the terminal pressure of the diagrams is not taken, as in the case of the other ships. That course of procedure

was rejected in consequence of the frequent changes of the cut-off during that 24 hours, on account of the variableness of the wind, sea, &c. And although the results from the two modes of calculation will not vary much, yet I thought that taking the average point of cutting off as shown by the log would give a more correct result, and hence their adoption.

Average pressure of steam per gauge,	9·9 lbs.
" revolutions per hour,	664·9
" consumption of coal per hour,	4203 "
" point of cutting off, from commencement of stroke, including clearance, &c., &c.,	42·9 ins.

From which we gather the following results :—

$$\frac{3848{\cdot}4 \times 42{\cdot}9 \times 2 \times 11{\cdot}08 \times 2}{1728} = 4234{\cdot}4$$

And $$\frac{4234\,4}{1064} = 3{\cdot}97 \text{ lbs. water.}$$

The loss from blowing to maintain the boiler water at its nominal density, viz: 1·75, was 12·9 per cent., its equivalent being ·510; and 3·97 + ·510 = 4·7 lbs. of water evaporated to one pound of coal. Residuum in clinker and ashes, 22·5 per cent.

The English government have recently despatched a steamer (the *Roebuck*) to Japan, for the express purpose of practically testing these coals; the results of which will be looked for with much interest.

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*The Magnesian Light.**

Magnesium is well known as the metallic basis of magnesia; it is much lighter than aluminum, as its specific gravity is only 1·74; it is of a silvery whiteness, undergoes no change in dry air, and is subject to but slow oxidation in a damp atmosphere, and that only quite superficially; it may be hammered, filed, and drawn into threads. At the beginning of the present century its properties were developed by Davy, and still more thoroughly by Busse. To obtain it pure is an expensive process; and as no practical advantage could hitherto be made of it, no one had attempted to discover a cheaper method of getting it. It was reserved to Bunsen to perceive a new property in this metal, and to suggest a practical application of it. Magnesium takes fire at the temperature at which glass melts, and burns with a steady and extremely vivid flame. In some photo-chemical investigations by Bunsen and Roscoe, experiments were made to test the illuminating capacity of a magnesium thread, when Bunsen discovered that the splendor of the sun's disc was only 524 times as great as that of the thread. Bunsen also compared the magnesium flame with ordinary lights, and found that a burning thread of 0·297 millimetres diameter, produces as much light as 74 stearine candles, of which five go to the pound. It is plain that it only needs a mechanical device to spin magnesium when heated into the form of a thread upon spools, from

* From the Lond. Chemical News, No. 27.

which they can be run off like the strips of paper in Morse's telegraphic apparatus, to render it of practical use. Such a magnesium lamp-wick would be far more simple and complete than the preparations for the use of the electric or the Drummond light. A spool with its thread, a clock-work to wind it off, with the spirit lamp, would be easily transportable. A rival, therefore, to the strong lights hitherto used is like to spring up in Bunsen's magnesium-lamp, in all those cases where the item of expense is likely to be slightly regarded, for example, in brilliant illuminations, light-houses, &c., for extraordinary degrees of illumination may be obtained by burning several of these threads of large dimensions at once.—*Engineer.*

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*On the Influence of Science on the Art of Calico Printing.**

By Professor F. Crace Calvert, F.R.S.

Calico printing has partaken of the general progress of the manufacturing arts; and this can be easily understood when it is remembered that it is based upon three distinct branches of knowledge—mechanics, art, and chemistry. Not being acquainted with machinery, I shall not attempt to describe the various mechanical improvements and machines which have been introduced; but shall confine myself to stating that ever since 1815, the period at which it was first extensively applied in the print works of Lancashire, machinery has gradually supplanted hand labor, and thereby immensely decreased the cost of production, at the same time that it has improved the beauty and precision of the results obtained.

Penciling and Block-Printing.—During the early part of this century, the production of designs upon calico was performed by means of hand-blocks, made of sycamore or pear-tree wood, 2 ins. or 3 ins. thick, 9 ins. or 10 ins. long, and about 9 ins. broad. The face of the block was either carved in relief into the desired pattern, like ordinary wood-cuts; or the figure was formed by the insertion edgewise into the wood of narrow slips of flattened copper wire, and the patterns were finished by the hand labor of women with small brushes, called pencilings. Owing to a strike amongst the block printers, in 1815, to resist the threatened introduction of machinery, great efforts were made on the part of the employers to render themselves independent of hand labor; and the result has been the gradual introduction of cylinder-printing. Without entering into the intricate details of the steps by which the art of engraving has been carried to its present high degree of perfection, I shall simply give an outline of the successive improvements alluded to.

Engraving.—The first kind of roller used was made by bending a sheet of copper into a cylinder, soldering the joint with silver, and then engraving upon the continuous surface thus obtained.

The second improvement consisted in producing the pattern on copper cylinders obtained by casting, boring, drawing, and hammering. In this case, the pattern is first engraved in intaglio upon a roller of

* From the London Engineer, No. 229.

softened steel of the necessary dimensions. This roller is then hardened and introduced into a press of peculiar construction, where, by rotary pressure, it transfers its design to a similar roller in the soft state, and the die being in intaglio, the latter, called the "mill," is in relief. This is hardened in its turn, and by proper machinery is made to convey its pattern to the full-sized copper roller. This improvement alone reduced the cost of engraving on copper rollers many hundreds per cent.; and, which is of far greater importance, made practicable an infinite number of intricate engravings which could never have been produced by hand labor applied directly to the roller.

A further improvement was made by tracing with a diamond on the copper roller, covered with varnish, the most complicated patterns by means of eccentrics, and then etching.

The combination of mill engraving with the tracing and etching processes naturally followed, adding immensely to the resources of the engraver and printer in the production of novel designs.

Another development of this art is the tracing of patterns on the surface of rollers, which has been effected by machines constructed on the principle of the pentagraph. Although this invention dates from 1834, still it is only of late years that it has been successfully applied.

But if mechanical art has greatly assisted the engraver, chemistry has rendered him equally important services, by enabling him to abandon costly and cumbrous modes of impressing by force the designs on the cylinder, substituting for them a great number of etching processes. By some of these processes, as by every other addition to the resources of the engraver, an entirely new and beautiful class of engraving is produced, unattainable by any other known means.

A very recent improvement is highly interesting in a scientific point of view. It is the application of galvanism to the diamond tracer. By combining the galvanic action with the eccentric motion, most beautiful and delicate engravings can be produced. This is effected by tracing the pattern with a varnish on a zinc cylinder, which is so placed in the engraving machine, that as a needle passes over its surface, and comes in contact with the zinc, the galvanic current is established, and, by simple machinery, causes the diamond to trace the corresponding pattern on the copper roller. The communication is so rapid and so precise, that this invention of Mr. Gaiffe, of Paris, bids fair to produce very important results. Galvanism is also made use of, for producing effects on roller surfaces by depositing copper thereon.

To give an idea of the extraordinary influence which the introduction of machinery and improvements in engraving have had in cheapening the cost of printed calicoes, I may state that large furniture patterns, such as are required for Turkish, Egyptian, and Persian markets, into which sixteen colors and shades enter, would have cost formerly from 30s. to 35s. per piece, because they would have required sixteen distinct applications of as many different blocks, and would have occupied more than a week in printing, where the same piece can now be printed in one single operation, which takes three minutes, and costs 5s. or 6s. So rapid is the progress of one branch of manu-

facture in connexion with another, that it has only recently been possible to produce the rollers capable of performing this operation, that is to say, cylinders of copper 43 ins. in circumference by 44 ins. long. For light styles of printing, the time required to print a piece of 36 yards is not more than one minute.

Chemistry.—But the discovery which has exercised more influence than any other on the progress of calico printing, is the application of chlorine gas as a bleaching agent. Previously to the employment of this gas (chiefly as bleaching powder), the imperfect bleaching of a piece of calico required six weeks; and as it had to be exposed to the action of the atmosphere, a large surface of land was required. Further, at that time, bleachers had to use potashes imported from Canada; whereas, at the present time, thanks to the progress of chemical knowledge, not only is soda-ash manufactured in this country, but, by the application of bleaching powder, calicoes are much better bleached in twenty-four hours than they were formerly by a six weeks' exposure to the atmosphere; and even when an extra cleaning and whiteness is required, as for madder goods, only two days are necessary. The aid of machinery renders possible the continuous process, that is to say, several hundred pieces of grey calico are sewn together, end to end, and made to pass from one operation to another, without any pause, until they are bleached. So rapid and economical is this method that the cost of bleaching a piece of calico does not exceed one or two pence. Chlorine, again, renders a great service to the calico printer, by enabling him, after his madder goods have been produced and soaped, to obtain fine whites without the necessity of exposing them for several days in the meadows to the action of the atmosphere. In fact, the discovery of garancine and alizarine, and their application to calico printing, have facilitated the production of madder styles at very low cost, as the whites of such goods require no soaping, and only a little bleaching or cleaning powder.

Cotton has this peculiarity as distinguished from wool and silk, that it will not fix any organic color, excepting indigo, without the interposition of a mordant, which is generally a metallic oxide or salt. The two most important discoveries in connexion with this necessity of calico printing were: first, that made in 1820, by Mr. George Wood, of Bankbridge, who found out the means of preparing calicoes with peroxide of tin, which enabled printers to produce a large variety of prints called steam goods; and, secondly, that of Walter Crum, Esq., F. R. S., who, in a paper presented to the British Association, at Aberdeen, in 1859, showed that the tedious process of ageing madder mordants for three or four days, might be dispensed with by passing the goods during a quarter of an hour through a moist atmosphere, at a temperature of 80° to 100°, where the mordants absorb the required quantity of moisture, and then rapidly undergo the chemical changes necessary to fit them for producing the black, purple, lilac, red, pink, and chocolate colors, which the madder root will yield immediately in the dyebeck, according to the nature of the mordant previously fixed in the cloth.

As it is impossible in the brief space of an hour to convey an idea how various colors are produced on prints, I shall confine my remarks to illustrating the interesting fact that abstruse science has brought to light various substances, which have lately proved valuable accessories to the resources of the calico printer. Thus Dr. Prout, some thirty or forty years ago, made the curious discovery that uric acid possessed the property of giving a beautiful red color, when heated with nitric acid, and then brought into contact with ammonia The substance thus obtained was further examined by Messrs. Liebig and Wöhler, in a series of researches which have been considered as amongst the most important ever made in organic chemistry; and this substance they called murexide. In the course of these investigations, they also discovered a white crystalline substance called alloxan. For twenty years both these substances were only to be found in the laboratory; but in 1851, Dr. Saac observed that alloxan, when in contact with the hand, tinged it red. This led him to infer that alloxan might be employed to dye woolens red; and further experiments convinced him that if woolen cloths were prepared with peroxide of tin, passed through a solution of alloxan, and then submitted to a gentle heat, a most beautiful and delicate pink color resulted. Subsequently, murexide was employed and applied successfully by Mr. Depouilly, of Paris, to dyeing wool and silk, and to printing calicoes, by the aid of oxide of lead and chloride of mercury as mordants; but the great obstacle to its extensive use was the difficulty of obtaining uric acid in sufficient quantity for its manufacture. The idea soon occurred to chemists to extract it from guano; and this is the curious source whence the chief supply of uric acid is obtained, and which enables Edmund Potter, Esq., and other printers, to produce the color called Tyrian purple.

Another example will be found in the successive scientific discoveries which have led to the discovery of the recently popular color, mauve. Lichens, which have been the subject of extensive researches on the part of Robiquet, Heeren, Sir Robert Kane, Dr. Schunck, and especially of Dr. Stenhouse, have yielded to those chemists several new and colorless organic substances, which, under the influence of air and ammonia, give rise to most brilliant colors, and amongst these are orchil and litmus. Dr. Stenhouse, in a most elaborate paper published by the Royal Society in 1848, pointed out two important facts: first, that the color-giving acids could be easily extracted from the weed by macerating it in lime water, from which the coloring matters were easily separated by means of an acid; and, secondly, the properties of certain coloring acids, which gave M. Marnas, of Lyons, the key which enabled him to produce commercially from lichens, a fast mauve and purple which up to 1857 had been considered impossible of attainment.

The commercial production by Mr. W. H. Perkin of another purple at the same time is not less interesting. Some thirty or forty years ago, Dr. Runge obtained from coal-tar six substances, amongst which was one called kyanol, which substance was thoroughly examined by

Dr. W. A. Hofmann, who proved it to be an organic alkaloid, and identical with a substance known by the name of aniline. Owing to the subsequent study of this substance by that eminent chemist, and the discovery that it yielded a beautiful purple color when placed in contact with bleaching powder, his pupil, Mr. W. H. Perkin, was induced to make experiments with a view to producing commercially a fast purple, in which he succeeded, and secured it by a patent in 1857. The process devised by this chemist is exceedingly simple. It consists in oxidizing aniline by means of bichromate of potash and sulphuric acid. I shall not attempt to give any further details on this subject, as they have been very ably described by Mr. Robert Hunt in the *Art Journal*.

More recently, Mr. Renard found a method of producing also from aniline by means of chlorine compounds a most splendid rose color, called by him fuchsiacine; and within the last few months, Mr. David Price has also succeeded in producing from aniline, by the employment of peroxide of lead, either a fast purple or a pink, called by him roseine, and a fast blue according to the mode of operating. All these colors require special mordants to fix them on calicoes or muslins; and the beautiful specimens which I have the honor to lay before you I owe to the kindness of Messrs. James Black and Co., and Messrs. Boyd and Hamel of Glasgow, who have fixed the last-mentioned colors by means of azotized principles, such as albumen, lactarine. &c.,

I cannot give a better idea of the immense magnitude of the calico-printing trade than by quoting the number of yards exported, which amounted in 1858 to 785,666,473, and give a price value of £13,-147,280.

I cannot conclude without expressing also my thanks to Mr. Wood, of the firm of Wood and Wright, and Mr. R. Leake, of the firm of Lockett, Sons, and Leake, Messrs. Dalglish and Faulkners, for the numerous and valuable specimens which they have kindly lent me to illustrate my discourse; and especially to Mr. W. Grant for the loan of a most interesting book, containing the patterns belonging to the late firm of Sir Robert Peel, Bart., which bears the date of 1790.

Persistent Activity of Light.

We take the following interesting facts on this subject from the *Cosmos*:—"Some weeks ago, M. Niepce de Saint-Victor came to see us, bringing with him a large tin tube, closed not with sealing-wax but hermetically, and rendered inaccessible to all external agencies except variations of temperature, by a complete soldering with tin or lead. He opened the tube in our presence, exposed, without unrolling it, a sheet of paper prepared with tartaric acid and insolated, which he had inclosed in the tube nearly a year before, poured on this sheet a few drops of nitrate of silver, and showed us that the nitrate was almost immediately blackened, exactly as it would have been in a strong light. It was impossible not to attribute this instantaneous action to the persistent action of the light absorbed a year ago by the

paper soaked in tartaric acid. If the experiment was more successful this time, although kept for a longer period, it was because of the much more perfect closure of the tube; and that which happened after a year would certainly happen after five or six years."

"Again, M. Busk has established the following fact: Plunge a sheet of paper into a solution of a properly chosen acid, organic or inorganic, for example, acetic or tartaric acid; dry it; render it sensitive by the bath of nitrate of silver, and dry it again; place it in contact with the drawing which it is desired to reproduce for a half hour or more; then expose the paper to the sun's rays, and a negative image of the drawing will be seen, which may be fixed by washing with common water. It is not even necessary that the exposure to the light should take place at once; the paper may be preserved for several days between two sheets of white paper without losing its property of developing the latent image under the influence of the sun's rays. What is more difficult to explain is that there is no necessity of insolating or exposing to light the original picture. M. Busk usually employs the following formula:—*Solution of organic acid:* water, 90 grammes; crystallizable acetic acid, 30; dip the sheet simply in it. *Bath:* water, 25 grammes; nitrate of silver, 3·60 grammes; crystallizable acetic acid, 3·5 grammes; the sheet may either be laid on the bath successively on its two sides, or be washed on each face by a brush."

"To these facts, or to their interpretation, M. Baron Thenard would oppose the following experiment which he has communicated to the *Philomathic Society.*—1st. During the night he *disinsolated* a sheet of common paper by exposing it to the vapor of water for an hour. 2d. He then divided the paper into two parts; one was laid aside for comparison, the other was rolled up and placed in a glass tube, to one end of which ozonized oxygen was supplied; at the end of a quarter of an hour the ozone was distinctly perceived at the other extremity; the paper was then withdrawn. 3d. This paper used in the same manner as M. Niepce's insolated paper produced the same effects; the paper kept for comparison produced none of them. 4th. A paper treated with chlorine or nitrate of silver and then ozonized gave, on the contrary, no sensible result. 5th. Common paper ozonized and kept for some time in a test tube disengages a smell which is not that of ozone but that of a very diffusible essence. What shall we conclude from this? added M. Thenard—That the phenomena of insolation described by M. Niepce are chemical phenomena, determined indirectly by the light, which acts in this matter only as an intermediate agent."

Manufacture of Stearine Candles.

At the meeting of the French Academy of Sciences of 18th June, 1860, M. Dumas presented a note from M. Cambacérès, who has studied thoroughly and for a long time the interesting question of the saponification of the fat-acids, their solidification, and transformation

into stearine candles. He has discovered that by substituting dilute nitric acid for the concentrated acid usually employed, and assisting the action by a long contact under the influence of heat, the quantity of the fatty matter which solidifies is considerably increased, and a very great economy introduced into the manufacture.

On the Thermodynamic Theory of Steam Engines with dry Saturated Steam, and its application to practice. By W. J. MACQUORN RANKINE, C. E., F. R. S., &c.*

Phil. Trans. 1859, p. 177; and Phil. Mag. S. 4. vol. xviii. p. 71.

This supplement gives the dimensions, tonnage, indicated horse-power, speed, and consumption of fuel, of the steam-ships whose engines were the subjects of the experiments referred to in the original paper. Results are arrived at respecting the available heat of combustion of the coal employed, and the efficiency of the furnaces and boilers, of which the following is a summary :—

No. of Experiment.	Kind of Boiler.	Total heat of combustion of 1 lb. of coal in ft-lbs., estimated from chemical composition.	Available heat of combustion of 1 lb. of coal in ft-lbs. computed from efficiency of steam and weight of coal burned per I. H. P.	*Available heat*, total heat = efficiency of furnace and boiler.
I.	Improved Marine Boilers of ordinary proportions.	10,000,000	5,420,000	0·542
III.		10,000,000	5,300,000	0·53
II.	Boiler chiefly composed of small vertical water-tubes, with very great heating surface.	11,560,000	10,110,000	0·88

$$\text{Available heat of combustion of 1 lb. of coal} = \frac{1{,}980{,}000 \text{ ft.-lbs.}}{\text{Efficiency of steam} \times \text{lb. coal per I. H. P. per hour}}$$

* From the Lond., Edin., and Dub. Philosophical Mag., June, 1860.

For the Journal of the Franklin Institute.

Particulars of the Clipper Bark James Welsh.

Hull built by E. F. Williams, Greenpoint, L. I. Owner, F. Alexandre, New York City. Commander, Capt. W. Magill. Intended service, New York to Balize (Honduras).

HULL.—Length of keel, 110 feet. Do. of main deck, 120 feet. Do. over all, 129 feet. Breadth of beam at midship section, 28 feet. Depth of hold, 16 feet 6 inches. Frames of white oak and yellow pine, and very securely fastened. Tonnage, 350 tons, but possesses a frame equal to a vessel of 600 tons.

Remarks.—In the erection of this vessel, there have been many im-

portant improvements upon the old method of ship-building, particularly in its internal arrangements. Her forecastle is admirably adapted for the comfort of seamen, being far superior to the old and miserably ventilated ones, which have invariably been so detrimental to the health of sailors. It is erected on the main deck, having two gangways on each side of the chain lockers, and a commodious room on either side of the gangways, each possessing four large berths.

These gangways are sufficiently large to admit of five persons in each to be seated at meals, and can, when necessary, be used to change clothing and as a protection from storms, whilst the sleeping apartments will at all times keep perfectly dry.

Each of the rooms contains a ventilator, which, when used in concert with the hatch in the topgallant-forecastle and the gangways, will insure the presence of a continual current of fresh air.

The after-house of this vessel (constituting cabin and dining-room) is 28 feet in length, and contains four state-rooms on each side for the accommodation of passengers. The forward portion of the house is separated from the after part, for the purpose of stowing hides, dry goods, and miscellaneous merchandize, by which arrangement they re ceive a thorough ventilation during the passage, thereby preventing that unhealthy miasma arising, as is usually the case when such articles are stowed in the hold.

In addition to these features, there are two tanks in her cockpit of sufficient capacity to hold 500 gallons of water each. The main rail and bulwarks included, are seven and a half feet in height and of great strength, in order to protect her deck load, which, upon all her return voyages, will consist of mahogany.

The above improvements are the design of her owner, and are worthy the attention of ship builders, ship owners, and all others who are interested in alleviating the many trials and discomforts of a much abused and sadly neglected class—our sailors. E. B.

Safety of Vessels at Sea.

A Dr. Brevard, of Grenoble, describes in the *Cosmos* a means of preserving a ship from sinking at sea, which, although not new as a proposition, has never to our knowledge been adopted, and merits a fair experiment at all events. The plan appears to consist in rendering the various compartments of the vessel air-tight, and arranging proper openings along the keel which may be closed by plugs or stop-cocks. If the vessel springs a leak, the compartment into which the leak opens is closed air-tight, and air forced in by a force-pump until the water is driven out at the leak, which is then to be stopped, and one or more of the escapes along the keel being opened, the air is continually forced in until all the water is expelled. Should fire take place below, the vessel may be scuttled by opening the lower escapes until the fire is extinguished, and be then raised again by means of the pumps. The same pumps may be used to ventilate the holds and ca-

bins of the vessel. In a steamer the force-pumps may be worked either by connexion with the main engine or by the feed engine; and when it is considered that a pressure of one additional atmosphere will correspond to a column of about thirty feet of water, and that our india-rubber goods furnish a cheap and simple way of rendering any opening practically air-tight, the plan seems feasible enough; at all events, considering the important use for which it is purposed, deserving of serious study.

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*On the Explosion of Hypophosphite of Soda.** By M. TROMMSDORFF.

Under the heading of "Caution,"† Dr. L. C. Marquart describes a violent explosion of the above salt, while its solution was being evaporated in a porcelain capsule, placed in a heated sand bath, for which reason too high a heat was assigned as the cause of the explosion. It was therefore thought necessary to avoid evaporating such a solution, either over the fire or in a sand bath, but to employ altogether a water bath for its evaporation. This operation has been carried on very frequently in my laboratory without the occurrence of the least accident, but last spring I experienced by a painful accident that even the low temperature of boiling water is no safeguard against explosions of this salt.

The neutral solution of hypophosphite of soda was evaporated in small portions in a porcelain dish, heated by a simple water bath, the concentrated liquid being constantly stirred with a glass rod or a porcelain spatula. The last portion had become nearly dry, when a violent explosion took place, breaking all the windows of the laboratory and seriously lacerating the face of the attending workman. Being near at hand, and supposing the explosion to have been caused by the neglect of the water bath, I hurried to the spot, but found the bath filled with boiling water, and was unable to discover the least suspicious circumstance from which the cause of the accident might have been explained.

The preparation which the author is using now is of French manufacture, and has a strong alkaline reaction. Should it, in this state, be less subject to explosions, it would be highly interesting to hear of the experience of the French and other chemists with regard to this new medicinal salt, which they are preparing in enormous quantities.

* From the Lond. Chemical News, No. 29. † *Archiv d. Pharm.*, lxxxv, 384.

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*Improvement in the Manufacture of Starch.**

A patent has recently been obtained by John Hamilton, of Belfast, for submitting starch—after it is deposited in the manufacturing process—to the action of a hydraulic press, in suitable boxes, so as to press all the water out of it, instead of evaporating all the moisture in artificially heated rooms, according to the usual practice. A great saving in fuel is thus effected by well known and very simple means.

* From the Lond. Chemical News, No. 10.

*Bitumenized "Paper" Pipes.**

The ingenious idea of hardening paper by means of an admixture of bitumen under the influence of hydraulic pressure, so as to convert it into a substitute for iron, is due, it appears, to M. Jaloureau, of Paris. The world has already become familiar with the utility and value of *papier maché* as a substitute for stone or marble in moulding, architectural castings, busts, and statues: it has also heard recently that the Chinese constructed their cannon of prepared paper lined with copper, and that they even make paper pipes,—that an eccentric character at Norwood has built himself a house of paper,—and that our American friends have invented a veritable paper brick;—but nothing, it is believed, has lately come before the British public, in the way of paper, so curious, and yet practicable, as these bituminous paper pipes. Testing experiments, conducted under the great clock-tower at the Houses of Parliament, are reported to have "proved that the material, while it possessed all the tenacity of iron, with one-half its specific gravity, had double the strength of stoneware tubes, without, moreover, being liable to breakage, as in the case of other material, and which frequently causes a loss to the contractor of some 20 or 25 per cent. on the supply." In order to test their strength, two of these bituminous paper pipes of 5-inch bore and half an inch thick were subjected to hydraulic power, and they are said to have sustained, without breaking or bursting, a pressure of 220 lbs. to the square inch, or equivalent to 506 feet head of water. The cost of the pipes is understood to be about one-half the cost of iron. Specimens of pipes employed in the transmission of gas at the Palace des Invalides during the last eighteen months were exhibited by Messrs. Joske & Young, the proprietors.

* From the Lond. Builder, No. 888.

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*Action of prolonged Heat and Water on different Substances.**

Mr. H. C. Sorby, an Englishman we believe, sends to the Academy of Sciences an account of some experiments he has made on the above subject. He put different substances and various solutions in glass tubes, sealed then hermetically, and then placed them in the boiler of a high pressure engine, and kept them there exposed to a temperature ranging from 145° to 150° C. for some months. Others he placed in an ordinary kitchen boiler, in which the temperature varied from 75° to 100° C. The first facts noticed are the decomposition of the glass tubes employed. Crown glass resisted the action best—better even than Bohemian—but it was sometimes acted on at but slightly elevated temperatures. English flint glass was easily decomposed by the prolonged action of water below 100°. A fragment of flint or Bohemian glass enclosed in a tube of crown glass with a *little* water, was more quickly decomposed than with much water. A moderately strong solution of nitric acid had little or no action on flint glass at 145° or 150°, while pure water soon changed it into a white crystalline mass. Wood exposed to a temperature of 145° without water,

* From the Lond. Chemical News, No. 30.

underwent but little change, while some with water became quite black. A brilliant black substance separated from the wood, but the water remained quite clear, although it had an acid reaction, due no doubt to acetic acid, and when the tube was opened a good deal of gas escaped. Some of the results obtained illustrate the pseudomorphosis of minerals, and of these experiments we hope the author will soon publish a fuller account.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM JUNE 1, TO JUNE 30, 1860.

Air Engines,	O. M. Stillman,	Stonington,	Conn.	26
———	"	"	"	26
Amalgamator,	G. E. Mills,	City of	N. Y.	26
Apples,—Cutting and Coring	G. C. Wright,	Le Roy	Ohio,	26
Auger,—Tenoning	Wm. A. Clark,	Bethany,	Conn.	12
Bagasse Furnaces,	C. A. Desobry,	Plaquemine,	La.	19
Bark,—Separating Qualities of	Joseph Brakely,	City of	N. Y.	5
Barometers,	Lum Woodruff,	Ann Harbor,	Mich.	5
Barrels,—Securing Heads in	G. W. Banker,	Medford,	Mass.	12
Bed Bottom,—Spring	W A Morse & D S Beans,	Boston,	"	19
Bedstead,	Reuben Jenkins,	Covington,	Ky.	5
———	Thomas Wall,	Jones' Station,	Ohio,	5
Bee-hives,	K. P. Kidder,	Burlington,	Vt.	26
Bells,—Ringing	Balthasar Kitt,	Cincinnati,	Ohio,	5
Belts,—Strain on Pulley	Duff and Keating,	City of	N. Y.	19
Blind Slat Machine,	Stephen Jackson,	Ossippee,	N. H.	19
Blowers,	Rufus Lapham,	City of	N. Y.	19
Boats,—Hook for Suspending	C. L. Williams,	Quincy,	Fla.	5
Bolt for Doors,	N. W. Bonney,	Victoria,	Texas,	26
Bolts for Store Shutters,	Wm. C. Fisher,	Charlestown,	Mass.	26
Bolting Chest,	Cogswell & McKiernan,	Buffalo,	N. Y.	12
Boom Jaws,—Elastic Lining	O. P. Rowland,	Jamesport,	"	5
Bonnet Box,	C. A. Taylor,	Chicago,	Ill.	26
Boot-jack,	George Wheeler,	City of	N. Y.	26
Boot & Shoe Cleaning Appar.	James Chesley,	Concord,	N. H.	19
——— Wiper,	J. K. Staman,	Mifflin,	Ohio,	5
Boots,—Congress	H. S. Holmes,	Lynn,	Mass.	19
Boots & Shoes,—Heel Guard	W. A. Harris,	Providence,	R. I.	5
Brakes,—Railroad	Nehemiah Hodge,	N. Adams,	Mass.	12
———	J. H. Steiner,	Philadelphia,	Penna.	19
———,—Self-acting Wagon	Wm. May,	Winchester,	Ohio,	5
Bran Dusters,	J. W. Houghtelin,	Du Quoin,	Ill.	26
Bridges,—Iron	J. P. Fisher,	Rochester,	N. Y.	26
Bridle Bit,	Henry Crane,	City of	"	5
Bung Cutter,	John Tiebout,	Brooklyn,	N. Y.	5
Burglars Alarm,	J. C. Huntley,	Philadelphia,	Penna.	12
Butter Worker,	Wm. H. Wiley,	Lockport,	N. Y.	12
Buttons,	Stephen Krom,	City of	"	5
Cap Fronts,—Mode of Binding	Leon Londisky,	City of	N. Y.	26
Carpenters Square,	James Hathen,	Philadelphia,	Penna.	26
Carpet Stretcher,	H. M. Hartshorn,	Malden,	Mass.	26
Carpets,—Laying and Stretch'g	F. Cist and others,	St. Louis,	Mo.	12
Casting Metals,—Fac'g Moulds	J. B. Hyde,	Newark,	N. J.	5
Chains,	P. D. Cummings,	Portland,	Me.	5
Chisel for Opening Boxes,	D. M. Dumzack,	Salem,	Mass.	26
Chronometer Escapement,	Thomas Morrison,	Kingston,	N. Y.	12
Churn,	N. D. Ross,	Braintrem,	Penna.	5
———	O. W. Stanford,	Cincinnati,	Ohio,	12
———	Harry Abbott,	N. Huron,	N.Y.	19

Churn,	S. A. Kerr,	Arbor Hill,	Va.	19
———	C. Wright & W. Phelps,	Sycamore,	Ill.	19
Claw Bar,	G. H. Beard,	Cincinnati,	Ohio,	12
Clothes Wringer,	Higgins & Willard,	Somerville,	Mass.	19
Clocks,—Calendar	Eben Pritchard,	Waterbury,	Conn.	5
Cocks,—Pull	George Leach,	City of	N. Y.	5
Coffee Pots,	Thomas Yates,	Dubuque,	Iowa,	19
Core Boxes,	J. S. Harper,	Baltimore,	Md.	5
Cornices of Sheet Metal,—Form.	John Lee,	Bolivar,	Ohio,	12
Corn Huskers,	D. M. Mefford,	Jeffersonville,	Ind.	26
—— and Cob Crushers,	Amos Glover,	Powhatan Pt.,	Ohio,	5
—— Planters,	Daniel Moyer,	N. Hamburgh,	Penna.	5
———	Ptollman Stover,	W. Alexandria,	Ohio,	5
———	Davis Dutcher,	Blue Grass,	Iowa,	26
———	T. S. Mills,	Iberia,	Ohio,	26
———	Levi Morris,	Woodbury,	Ill.	26
———	D. C. Myers,	Richmondale,	Ohio,	12
———	J. L. Smith,	Neoga,	Ill.	26
———	Taylor & Sprague,	Prairie City,	"	26
—— Shellers,	E. A. Smead,	Tioga,	Penna.	5
———	J. P. Smith,	Hummelstown,	"	19
Cotton Bales,—Iron Tie for	C. C. Bier,	New Orleans,	La.	26
——— Scrapers,	J. M. Cobb,	Jackson,	Tenn.	26
Coupling and Uncoupling Cars,	Wm. A. Herrick,	Leeds,	Me.	19
Couplings,—Car	J. S. Sammons,	City of	N. Y.	5
———	L. and W. H. Waddel,	Staunton,	Va.	5
———	Wm. W. Culpepper,	Augusta,	Ga.	12
——— for Railroad Cars,	George Lavally, Jr.,	Champlain,	N. Y.	26
Coupling for Shafting,	Samuel Hall,	City of	"	5
———	H. L. Haynes,	Keene,	N. H.	26
Cultivator Teeth,	C. H. Sayre,	Utica,	N. Y.	19
———	Turner & Smith,	Sunapee,	N. H.	26
Cultivators,	Vines Harwell,	Walker Co.,	Ga.	5
———,—Cotton	W. F. Johnson,	Wetumpka,	Ala.	5
———	R. M. Brooks,	Greenville,	Ga.	26
———	J. F. Cameron,	Livingston Co.,	Mo.	26
———	James Charlton,	Alleghany,	Penna.	26
———	O. F. Fitch,	Morristown,	Ind.	26
———	T. and R. Kinghorn,	Morgan,	Ohio,	26
———	J. M. Williams,	Greenville,	Ga.	26
Cup,—Telescopic Drinking	P. H. Niles,	Boston,	Mass.	5
Cut-off for S'm. Engs.,—Variable	David Fellenbaum,	Lancaster,	Penna.	5
Currying Knife,	Wm. P. Moses,	Exeter,	N. H.	5
Curtain Slide,—Window	Gregor Trinks,	Jersey City,	N. J.	26
Cutlery,—Soldering Handles of	E. A. Godfrey,	Hartford,	Conn.	12
———	"	"	"	12
Dating Machine,	G. J. Hill,	Buffalo,	N. Y.	26
Ditching Machines,	P. W. Adaire,	Hays' Creek,	Miss.	5
Dove-tailing Machines,	H. W. Jelliff,	Appleton,	Ohio,	12
Drills,—Rock	E. L. Foote,	Springfield,	Ill.	5
Drill Rest,	Cornelius Teachout,	Waterford,	N. Y.	19
Dry Dock,—Marine	H. J. Crandall,	New Bedford,	Mass.	12
Dulcimers,	John Low,	Clinton,	"	19
Dynanometers,	Warren & Damon, Jr.,	Boston,	"	26
Eave Troughs,—Making	Ludlow Pierson,	Jeffersonville,	Ind.	26
Egg Beater,	McLean & Morley,	City of	N. Y.	19
Electricity,—Utilizing Atmos.	H. C. Vion,	Paris,	France,	19
Envelope,	Benjamin Morrison,	Philadelphia,	Penna.	19
Faucets,	D. H. Thorp,	Chelsea,	Mass.	19
———	I. C. Tate,	New London,	Conn.	12
Fenders for Docks, Wharves, &c.,	Jacob Moomey,	Clinton,	Iowa,	19

Fibrous Materials,—Surfacing	Wm. Fuzzard,	Charlestown,	Mass.	19
Files,—Manufacture of	M. D. Whipple,	Charlestown,	Mass.	26
Filters,	T. C. Simonton,	Paterson,	N. J.	26
Fire Arms,—Self-loading	N. W. Brewer,	Williamsport,	Penna.	12
———	James Lord,	Minersville,	"	12
—— Brick,	Eben Seavey,	Boston,	Mass.	12
—— Engines,—Nozzle for	J. C. Howels,	Madison,	Wis.	26
—— Escape,	W. B. Avery,	Cambridge,	Mass.	5
———	C. W. Crosley,	City of	N. Y.	19
———	J. J. Holwell,	"	"	26
———	Wm. McCord,	Sing Sing,	"	26
———	Patten and Terry,	Albany,	"	26
—— Wood,—Bundling	C. J. Hobe,	City of	"	19
Flour,—Machines for Packing	S. A. Clapp,	Hamilton,	Ill.	5
Fog Alarms,	C. L. Daboll,	New London,	Conn.	26
Fruit,—Apparatus for Drying	Isaac Randall, 2d,	Claremont,	N. H.	19
Fruits,—Machine for Stoning	Robert McCormick,	Greenville,	Va.	26
Furnaces,	C. F. Baxter,	Boston,	Mass.	19
Furniture,—Folding	Albert Tracy,	U. S. A.,	——	12
———,—Polish for	André Sabatier,	City of	N. Y.	19
Gauge for Filling Barrels,	W. H. Noyes,	Boston,	Mass.	5
Game-box,	S. F. Brooks,	Weston,	"	19
Garter,	J. P. Fuller,	City of	N. Y.	26
Gas Burners,	Wendell Wright,	"	"	12
———	Woodworth & Wethered,	San Francisco,	Cal.	12
———	James McGlensey,	Philadelphia,	Penna.	19
—— Holders,	O. L. Lawson,	City of	N. Y.	26
——,—Manuf. of Illuminating	Levi Short,	Buffalo,	"	12
—— Metres,—Liquids for Fluid	James Taylor,	Dartmouth,	Mass.	5
—— Regulators,	S. H. Whitaker,	Cincinnati,	Ohio,	12
——,—Broiling or Roasting by	W. F. Shaw,	Boston,	Mass.	19
—— Tubes,—Flexible	John Butler,	Brooklyn,	N. Y.	12
Gases,—Naphthalizing	E. H. Ashcroft,	Boston,	Mass.	5
Gearing,	P. D. Cummings,	Portland,	Maine,	5
Grain Binders,	Herman Kaller,	Perry,	Ill.	5
——— ———	W. W. Burson,	Yates City,	"	26
——— Separators,	McGahey and Foote,	McGaheysville,	Va.	12
Grindstones,—Dressing	J. F. Schuyler,	Philadelphia,	Penna.	5
Gun,—Toy	W. H. Stevens,	Syracuse,	N. Y.	12
Hame Tug and Buckle,	J. S. Topham,	Washington,	D. C.	12
Harrows,	D. C. Colby,	Newport,	N. H.	26
———	S. A. and C. C. Morgan,	Auburn,	N. Y.	26
Harvesters,	Robert Bryson,	Schenectady,	"	5
———	S. and J. H. Barley,	Longwood,	Mo.	19
———	Joseph Woodruff,	Rahway,	N. J.	5
———	Benaiah Titcomb,	Baltimore co.,	Md.	5
———,—Automatic Rakes	John Ollis,	Bloomington,	Ill.	26
———,—Raking Attachment	Daniel Guptail,	Elgin,	"	26
———,——— Apparatus	A. B. Smith,	Clinton,	Penna.	19
Hat Conformatures,	John Dickson, Jr.,	Brooklyn,	N. Y.	5
—— Cushion,	A. D. Purinton,	Dover,	N. H.	26
Hats,—Cigar Rack for	F. I. Miller,	Brooklyn,	N. Y.	19
Hay Elevators,	Wm. E. Durkee,	Fort Edward,	"	12
——,—Loading	Wm. Dixon,	Chicago,	Ill.	26
———	T. J. Jolly,	Olean,	Ind.	26
——,—Unloading	H. H. Angell,	Clermont,	Iowa,	26
Heating Air by Steam,	James Hollingsworth,	Chicago,	Ill.	5
——— Apparatus,	Lyman Bridges,	"	"	19
Hinges,	A. W. Sweeny,	Washington,	D. C.	26
Hinge,	H. M. Zimmerman,	"	"	26
Hook,—Self-mousing	J. R. Henshaw,	Middletown,	Conn.	12
Horse-powers,—Gearing for	Cyrus Avery,	Tunkhannock,	Penna.	5

Horse-shoes,	T. M. Coleman,	Philadelphia,	Penna.	12
Hose Pipe,	George Smith,	Macon,	Ga.	12
Hot-air Engine,	Wm. D. Grimshaw,	Newark,	N. J.	19
Hydrants,	Alfred Johnson,	Philadelphia,	Penna.	12
India Rubber,—Treatment of	A. K. Eaton,	City of	N. Y.	19
Inoculating,—Apparatuses for	Alfred Stauch,	Philadelphia,	Penna.	12
Jars,—Moulds for	George Scott,	Cincinnati,	Ohio,	5
Key Seats,—Mach. for Cutting	W. C. Bement,	Philadelphia,	Penna.	5
Lamps,	E. J. Hale,	Foxcroft,	Me.	12
———	Jennison and Hale,	"	"	12
———	Chas. Miller,	St. Louis,	Mo.	12
———	O. and H. S. Snow,	West Meriden,	Conn.	12
———	E. J. Hale,	Foxcroft,	Me.	19
———	"	"	"	26
———,—Coal Oil	R. S. Merrill,	Lynn,	Mass.	19
———,—Vapor	Joseph Clarke,	Syracuse,	N. Y.	12
———	C. W. Richter,	Madison,	Ga.	12
———	George Walker,	Philadelphia,	Penna.	26
Lath Machines,	McLean & Gummer,	Indianapolis,	Ind.	26
Leather,—Buffing and Reducing	Joshua Turner,	Cambridgeport,	Mass.	5
———,—Finishing	S. P. Cobb,	S. Danvers,	"	5
———,—Skiving	E. T. Ingalls,	Haverhill,	"	5
Leather-splitting Machs.,—Feed	D. H. Chamberlain,	West Roxbury,	"	5
Lifting Handles,	Joseph Ottner,	New Britain,	Conn.	26
Light Joints,—Drop	T. G. Arnold,	City of	N. Y.	5
Lock,	E. W. Brettell,	Newark,	N. J.	26
Locks,	Linus Yale, Jr.,	Philadelphia,	Penna.	12
Lozenge Machines,	Rhoda Sowle,	Fall River,	Mass.	19
Lubricating Journals,	Andrews & Carr,	Palo Alto,	Penna.	19
Medical Compound,	J. J. Reeves,	Sulphur Sp'gs,	Texas,	26
Measuring Liquids,—Appa's for	Hiram James,	Barclay,	Ill.	5
———	John C. Rankin,	Mt. Vernon,	N. Y.	12
Mills,	Leonard Coleman,	New Orleans,	La.	12
———	E. D. Clark,	Earlville,	N. Y.	26
———	H. C. Velie,	Poughkeepsie,	"	26
———,—Grinding	Samuel Moore,	Wellsburgh,	Va.	12
Millstones,—Dressing	Joel Bowman,	Somerset,	Ohio,	5
Millstone Dress,	J. W. Gaines,	Melrose,	Texas,	26
Millstones,—Cooling, &c.,	Akins and Babcock,	Dryden,	N. Y.	12
Mirrors,—Silvering	H. Poissonnier,	City of	"	19
Mowing Machines,	Chester Bullock,	Jamestown,	"	5
Nail-cutting Machine,	Wm. Wickersham,	Boston,	Mass.	26
Neck Stock,	Wm. Watson,	Lowell,	Ind.	12
Needles,—Machine for Making	Frederic Plant,	City of	N. Y.	19
Newspaper File,	J. N. Jacobs,	Worcester,	Mass.	19
Oil from Resin,—Distillation of	Samuel Frazer,	Galena,	Ill.	12
Ores and Coal,—Desulphurizing	Wm. H. Letterman,	Philadelphia,	Penna.	26
—— of Gold, &c.,—Treating	John McCullock,	San Francisco,	Cal.	26
Paddle Wheel,—Feathering	R. Williams & S. Wilson,	Buffalo,	N. Y.	12
Paints,—Mixing	S. G. Cheever,	Boston,	Mass.	5
Paper,—Machine for Wetting	Andrew Overend,	Philadelphia,	Penna.	26
Pegging Machines,	J. J. Greenough,	City of	N. Y.	26
Pen and Pencil Case,	G. E. Frew,	Brooklyn,	"	12
Pen-holder,	A. F. Warren,	"	"	19
Photographic Baths,	Wm. and Wm. H. Lewis,	City of	"	26
——— Cameras,	E. M. Corbett,	"	"	19
Piano-forte Hammers,—Covers	Jehiel Munson,	Burlington,	Vt.	19
Picks,	J. C. Reed,	Cincinnati,	Ohio,	5
Pitcher,—Beer	O. Z. Pelton,	Middletown,	Conn.	19

Pitchers,—Spout and Lid of	David Baker,	Harwich,	Mass.	19
Planing Warped Surfaces,	John Green,	Brooklyn,	N. Y.	19
Plane-iron Sharpeners,	Joshua Turner,	Cambridgeport,	Mass.	26
Ploughs,	Whitman Price,	Wayne Co.,	N. C.	5
———	C. F. Richter,	Columbia,	S. C.	5
———	R. S. Williams,	Bairdstown,	Ga.	26
———	T. R. Markillie,	Winchester,	Ill.	19
———	Pomeroy & Hudson,	Providence,	R. I.	12
———	J. M. Cobb,	Jackson,	Tenn.	26
———,—Moles for Drain	Hawkins & Puntenney,	Canton,	Ill.	12
———	Shipp & Crenshaw,	La Grange,	Tenn.	26
———	J. P. Thompson,	Jackson,	"	26
———,—Steam	Albert Bigelow,	Hamilton,	C. W.	19
———————	L. B. Woolfolk,	Nashville,	Tenn.	19
———————	" "	"	"	26
Plumbers Joints,—Making	J. P. Hayes,	Philadelphia,	Penna.	19
Porter Bottle Boxes,	G. W. Righter,	"	"	5
Post-hole Diggers,	John Lee,	Bolivar,	Ohio,	26
Preserving Meats,	G. W. Oliver,	City of	N. Y.	19
Printing Press,	M. S. Beach,	Brooklyn,	"	26
———	G. C. Howard,	Philadelphia,	Penna.	26
———	Smith & Orvis,	Oakfield,	Wis.	26
———	A. B. Taylor,	Newark,	N. J.	26
Presses,—Cotton	George Milliran,	Byhalia,	Miss.	5
Propeller,—Marine	D. D. Porter,	U. S. N.,		12
Prussian Blue,	James Clark,	Newark,	N. J.	12
Pumps,	N. S. Bean,	Manchester,	N. H.	12
———	George Palmer,	Littlestown,	Penna.	5
———, &c.,—Air Vessels of	A. H. Rauch,	Bethlehem,	"	5
———	Edward Wade,	Norwich,	Conn.	12
Quartz-crushers,	Philip Estes,	Leavenworth,	K. T.	12
Quartz,—Stamping Metal	Gates and Frazer,	Chicago,	Ill.	19
———,—Machines for Crushing	F. N. Du Bois,	"	"	26
Railroad Car Trucks,—Bolsters	M. C. Andrews,	Lawrence,	Mass.	5
——— Wheels,	J. H. Steiner,	Philadelphia,	Penna.	19
——— Station Indicators,	E. M. & J. E. Woodward,	"	"	26
——— Cars,—Sprinkl'g attach.	Henry Mitchell,	Cincinnati,	Ohio,	19
Railroads,—Iron Rails for Street	S. A. Beers,	Brooklyn,	N. Y.	19
Rakes,—Bending Teeth for	Henry Brandt,	Columbia,	Penna.	5
Reaping and Mowing,	Daniel Sheets and others,	Suisun City,	Cal.	19
Roofing Houses,—Composition	J. A. Hawley,	Jackson,	Mich.	5
Roots,—Houses for Preserving	T. V. Bush,	Gallatin,	Tenn.	5
Rotary Engines,	T. H. Witherby,	Worcester,	Mass.	5
———————	J. Rix & J. S. Shaw,	Springfield,	Mo.	26
Saccharine Juices,—Evaporating	Gilbert & Ames,	Bayou Goula,	La.	5
Saddle,—Military	W. H. Jenifer,	Baltimore,	Md.	26
Sad-iron Heater,	W. J. Andrews,	Columbia,	Tenn.	5
Safes,—Composition for Lining	Jabez Jenkins,	Philadelphia,	Penna.	19
Sails,—Securing Reef Points of	J. W. Logan,	"	"	5
Sash-fastener,	Lafayette Bartoo,	East Aurora,	N. Y.	19
Sausage-filler,	J. G. Perry,	S. Kingston,	R. I.	26
Scroll-sawing Machine,	W. P. Wood,	Washington,	D. C.	19
Saws,—Grinding	Wm. Dougherty,	Philadelphia,	Penna.	19
——,—Sharpening	John Armour,	Helena,	Ark.	5
——,—Tabs for Cross-cut	T. S. Disston,	Philadelphia,	Penna.	5
Screws and Nuts,—Anti-friction	C. F. Spencer,	Rochester,	N. Y.	5
——,—Die-plate for Cutting	E. P. Gleason,	Providence,	R. I.	19
Seats,—Adjustable Carriage	I. L. Vansant,	Red Lyon,	Del.	19
———————————	J. A. Naylor,	Rahway,	N. J.	26
Seed Planters,	H. C. Fairchild,	Brooklyn,	N. Y.	5
———————	James Green,	Kennett Sq.,	Penna.	5

Seed Planters,	A. J. Rogers,	Stephentown,	N. Y.	19
———	Hervey Sloan,	Franklin,	Ind.	26
———	David Warren,	Gettysburgh,	Penna.	26
———	Elijah Young,	Fayetteville,	Mo.	26
Seeds,—Planting Cotton	Whitman Price,	Mount Olive,	N. C.	5
———	Benjamin Owen,	Dayton,	Ohio,	26
———	W. A. and J. F. Suddith,	Charlestown,	Va.	26
Seeding Machines,	Matthew Mitchell,	Altona,	Ill.	5
———	M. B. Rupp,	McVeytown,	Penna.	19
———	D. W. M. Lower,	Albia,	Iowa,	26
———	Joseph Sutter,	City of	N. Y.	26
———	Thomas Wilson,	Winterset,	Iowa,	26
———	Wm. Workman,	Ripon,	Wis.	26
Sewing ———	Scofield and Rice,	Adams,	N. Y.	5
———	W. H. Smith,	Birmingham,	Conn.	19
———	Joseph Geiermann,	Albany,	N. Y.	19
———	I. M. Rose,	City of	"	19
———	J. S. Steiner,	St. Louis,	Mo.	19
———	E. S. Yentzer,	Middletown,	Penna.	19
———	J. E. A. Gibbs,	Mill Point,	Va.	26
———	Austin Leyden,	Atlanta,	Ga.	26
———	Fr. Toggenburger,	Chicago,	Ill.	26
———,—Guides for	Wm. Price,	City of	N. Y.	19
——— ———	Wm. Rankin,	Richmond,	Va.	19
———,—Hemmers	W. P. Mitchell,	Baltimore,	Md.	26
———,—Marking in	H. W. Fuller,	Brooklyn,	N. Y.	5
———,—Shuttles	George Juengst,	City of	"	26
———,—Starting	T. J. Alexander,	Westerville,	Ohio,	12
Shingle Machines,	McLean and Grummer,	Indianapolis,	Ind.	5
———	J. D. Chism,	Albany,	N. Y.	12
———	E. T. Wheeler,	Cannelton,	Ind.	19
Shingles from Bolt,—Sawing	J. M. Carlisle,	Greenwood,	S. C.	19
Ships Windlass,	A. I. Gove,	San Francisco,	Cal.	12
Shoe Tips,—Cutting Blanks for	G. A. Mitchell,	Turner,	Me.	26
———,—Swaging	"	"	"	26
Shutter Operator,	Chas. Seltman,	Washington,	D. C.	26
Skirt Hoops,	Stokes & Jones,	City of	N. Y.	12
Skirts,—Making Hoop	Cæsar Newman,	"	"	26
———,—Manufacturing Skeleton	F. S. Otis,	Brooklyn,	"	5
———,—Skeleton	S. S. Sherwood,	City of	"	26
Sleighs,—Attach. Whiffletrees to	A. P. Hutchinson,	Pembroke,	N. H.	26
Spoke Machines,	Stam and Shubert,	Sardinia,	Ohio,	19
Spring Balances,	Wm. A. Crowell,	Salisbury,	Conn.	26
———,—Door	Jacob Post,	Newark,	N. J.	12
Springs,—Car	Richard Vose,	City of	N. Y.	5
———	"	"	"	12
———,—Tempering Steel	C. G. & H. M. Plympton,	Walpole,	Mass.	5
Stave Machine,	Wm. Trapp,	Elmira,	N. Y.	12
Steam Boiler,	J. S. Colvin,	Pittsburgh,	Penna.	12
——— Boilers,	M. R. Clapp,	Seneca Falls,	N. Y.	12
———,—Alarm Gauge	E. A. Kimball,	Boston,	Mass.	19
———,—Explosion of	H. L. Justice,	Nashville,	Tenn.	12
———,—Feed-water	Ephraim Pierce,	Cincinnati,	Ohio,	12
———	Wm. C. Drum,	Bellevernon,	Penna.	26
——— Engines,—Reg. Exhaust	James Thierry,	Detroit,	Mich.	26
———,—Slide Valves	E. M. Lewis,	Philadelphia,	Penna.	12
——— Pressure Gauge,	Wm. H. Allen,	Brooklyn,	N. Y.	19
——— Radiators,	A. P. Pitkin,	Hartford,	Conn.	12
——— Stuffing-box for Rolls,	Hugh Campbell,	Newtown,	"	12
——— Trap,	C. C. Walworth,	Boston,	Mass.	19
——— Valve,	Leopold Bennett,	Pittsburgh,	Penna.	5
Steering Apparatus,	A. D. Rollins,	Green Point,	N. Y.	19
Stills,	S. Godfrey and others,	Fairfield,	Ohio,	26

Stop-cocks,	Robert Nicoll,	City of	N. Y.	5
Stoves,	W. H. Smith,	Newport,	R. I.	19
——,—Cooking	S. S. Jewett,	Buffalo,	N. Y.	12
———	A. S. Sterling,	"	"	19
Stump Extractors,	A. Broughton,	Malone,	"	19
———	John Hamlyn,	Bellevue,	Mich.	26
———	Nathan Parish,	Galesburgh,	"	26
Sugar,—Clarifying	H. G. C. Paulson,	City of	N. Y.	19
——,—Machine for Cutting	T. H. Quick,	"	"	26
Sulphurous Acid,—Manufac. of	Marcelin & Eude,	New Orleans,	La.	12
Table Plate,	D. H. Shirley,	Boston,	Mass.	12
Tin Boxes,—Making	C. J. Haywood,	Durham,	Conn.	5
Tires,—Heating Wagon	I. N. Whitaker,	Foreston,	Ill.	12
——,—Upsetting	Henry Barringer,	Wataga,	"	19
Tobacco Press,	John Sweeney,	Chicago,	"	26
Tooth Brush,	H. N. Wadsworth,	Washington,	D. C.	19
Torch for Night Processions,	Isaac Edge,	Jersey City,	N. J.	12
Torches,—Gas	G. C. Brower,	New Orleans,	La.	5
Trap,—Animal	Wm. Wright,	Philadelphia,	Penna.	19
Tubes,—Coat. for inter. of metal	John Matthews, Jr.,	City of	N. Y.	5
Turbine Wheels,—Hanging	A Warren & E Damon, Jr.,	Boston,	Mass.	5
Tweer,	Marvin Mead,	Bedford,	Mich.	12
Type,—Setting,	Henry Harger,	Delhi,	Iowa,	26
——,—Scouring	J. G. Pavyer,	St. Louis,	Mo.	26
Typography,	Villet-Collignon & George,	Paris,	France,	12
Ventilation of Casks,	Louis Wilhelm,	Buffalo,	N. Y.	19
Vehicles,—Shafts to two-wheel	H. M. Walker,	Watertown,	Conn.	19
Vulcanizing Rubber,	G. E. Hays,	Buffalo,	N. Y.	12
Washboard,	Isaac Cook,	Mt. Pleasant,	Iowa,	5
Washing Machine,	H. Ehrman and others,	Annville,	Penna.	5
———	J. W. Crane, Jr.,	Freeport,	Ill.	12
———	P. Z. Allen,	Knox,	N. Y.	26
Watch Chains,	C. B. Carpenter,	N. Attleboro',	Mass.	19
——— Chain Hook,	E. N. Foote,	City of	N. Y.	26
——— Key and Guard Bar,	D. F. Elmer,	Haydenville,	Mass.	26
Watches,—Constructing Rims	C. W. Clewley,	Providence,	R. I.	19
Water Closets,	Thomas Grundy,	Boston,	Mass.	26
——— Elevators,	John Champlin,	E. Middlebury,	Vt.	26
——— in Pipes,—Reg. pressure	James Stratton,	Brooklyn,	N. Y.	5
——— Wheel,	A. Morehouse,	Farmer,	"	12
——— Wheels,	Caleb Bond,	Richmond,	Ind.	26
Weighing and Bagging Grain,	J. M. Fish,	Buffalo,	N. Y.	5
Willows, &c.,—Removing Bark	L. A. Beardsley,	S. Edmeston,	"	26
Window Blinds,	C. W. Smith,	Evans,	"	26
——— Curtain,	G. L. Kelty,	City of	"	5
Windmills,	Walter Peck,	Rockford,	Ill.	19
Wire Rope,—Making	Cornelius Collins,	Brooklyn,	N. Y.	19
Wood and Metal,—Finishing	George Stover,	New Britain,	Conn.	19
Wrench,	A. T. Gove,	San Francisco,	Cal.	12

EXTENSIONS.

Dredging Machines,	Carmichael & Osgood,	Brooklyn,	N. Y.	5
Stoves,—Cooking	R. D. Granger,	Albany,	"	12

ADDITIONAL IMPROVEMENTS.

Cakes,—Cutting and Panning	J. H. Shrote,	Baltimore,	Md.	26
Molding Machines,	E. M. Smith,	Shelbyville,	Ind.	26
Quartz,—Crushing	J. C. Dickey,	Saratoga Sp'gs,	N. Y.	12
Skates to Boots,—Attaching	T. S. Whitman,	City of	"	19
Steering Apparatus,	Daniel Jones,	Boston,	Mass.	26
Tile,—Laying Drain	B. B. Briggs,	Sharon,	Ohio,	26

RE-ISSUES.

Corn-shellers,	Nathaniel Drake,	Newton,	N. J.	12
Grass,—Machines for Cutting	C. H. McCormick,	Chicago,	Ill.	5
———	"	"	"	5
———	"	"	"	5
Hair Brush Handles,—Finishing	Thomas Mitchell,	Lansingburgh,	N. Y.	26
Harvesters,—clover & grass seed	W. N. Whitely, Jr.,	Springfield,	Ohio,	19
———	"	"	"	19
———	"	"	"	19
———,—Grain & Grass	Jacob Swartz,	Buffalo,	N. Y.	5
———	Cyrenus Wheeler, Jr.,	Poplar Ridge	"	5
Hose Pipe,—Coating for	N. Y. Rubber Company,	City of	"	5
India Rubber,—Vulcanizing	J. P. Trotter,	"	"	19
Lenses,—Fluid	Seligman Kakeles,	"	"	26
Reaping & Mowing Machines,	C. H. McCormick,	Chicago,	Ill.	5
———	"	"	"	5
———	"	"	"	5
Reflector,—Night-light	John Wyberd,	City of	N. Y.	12
Skeleton Hoop Skirts,	Cæsar Newmann,	"	"	26
Railroad Cars and Carriages,	P. G. Gardiner,	"	"	12
Steering Apparatus,	Wm. Godsoe,	Manchester,	Mass.	12
Water-closet,	Wm. S. Carr,	City of	N. Y.	12
Water Wheel,	J. P. Collins,	Troy,	"	12
Window Stop,	Williams & Heaton,	Providence,	R. I.	12

DESIGNS.

Bust of Abraham Lincoln,	L. W. Volk,	Chicago,	Ill.	12
Carpet Patterns,	E. J. Ney,	Lowell,	Mass.	12
——— Pattern (11 cases),	H. G. Thompson,	City of	N. Y.	19
Carpets,	E. J. Ney,	Lowell,	Mass.	12
Decanter Stoppers,	Wm. Pountney,	City of	N. Y.	19
Fire Shovel (4 cases),	Lemuel Morgan,	S. Norwalk,	Conn.	19
Nut-cracker,	S. G. Smith,	City of	N. Y.	12
Pump,	Birdsill Holly,	Lockport,	"	19
Range,—Cooking	A. C. Barstow,	Providence,	R. I.	12
———,—Cook's	Gardiner Chilson,	Boston,	Mass.	12
Roofs,—Ornamental Ridge	J. L. Jones,	Slatington,	Penna.	12
Stove,	S. W. Gibbs,	Albany,	N. Y.	12
——,—Cook's,	N. S. Vedder,	Troy,	"	12
——,—Cooking	R. H. N. Bates,	Providence,	R. I.	12
——,—Parlor	Louis Meyer,	St. Louis,	Mo.	19

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, August 20, 1860.

John Agnew, Vice-President, in the chair.

Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Letters were read from the Royal Society of London, and from the State Librarian of Pennsylvania, Harrisburgh, Penna.

Donations to the Library were received from the British Government, the Royal Society and the Statistical Society, London; the Royal Cornwall Polytechnic Society, Falmouth, England; the Nieder-Osterreichischen Gewerbe Vereines, Vienna, Austria; the Smithsonian Institution, and the Hon. P. F. Thomas, Commissioner of Patents, Washington, D. C.; the Maryland Agricultural College, Prince George's County, Maryland: Wm. J. Lewis, Esq., San Francisco,

California; Dr. Chas. M. Wetherill, Lafayette, Indiana; Messrs. Little, Brown & Co., Boston, Mass.; Messrs. C. W. Eliot and F. H. Storer, Cambridge, Mass.; J. S. Homans, Esq., and the Mercantile Library Association of the City of New York; the Mercantile Library Association of Brooklyn, New York; and Prof. John F. Frazer, Philada.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer's statements of the receipts and payments for the months of June and July were read.

The Board of Managers and Standing Committees reported their minutes.

Four resignations of membership in the Institute were read and accepted.

Candidates for membership in the Institute (12) were proposed, and the candidates proposed at the last meeting (5) duly elected.

Mr. Howson exhibited a specimen of a hand-saw manufactured by Mr. H. Disston, of the "*Keystone*" Saw Works of this city.

In form and weight it differed but little from hand-saws of ordinary construction; it is, however, by its peculiar construction, rendered available as a rule, a square, a level, and a plumb-rule. On the handle of the saw are formed two shoulders at right angles to the back edge of the blade, thus converting the instrument into a square. In the handle are let two spirit tubes, one being placed at right angles to, and the other parallel with the back edge of the blade, so that the latter can be applied as a level or plumb-rule, the blade itself being graduated into feet and inches for ordinary measuring purposes.

Mr. Howson also exhibited a specimen of fractured brass submitted by Mr. T. Shaw, of this city. The specimen consists of a disk, three inches in diameter and about one-fourth of an inch thick, with a central hub on one side. The fracture (which appears to have taken place while the metal was being turned in a lathe) consisted of the entire separation of a piece varying from one-thirty-second to one-sixteenth of an inch in thickness from the main body of the disk, the fracture being nearly in a plane parallel with the face of the disk.

The President remarked that although the specimen was a curious one, such fractures were not unusual; that it was no doubt owing to some hesitation in pouring the molten metal into the mould, an opinion concurred in by members present.

Mr. H. also exhibited a specimen of a boot, the leg and foot of which was made of one piece of leather folded together and presenting a single seam. The specimen was submitted by Mr. Michael Fritz, No. 1218 Whitehall St., the agent in this city for the inventor and patentee, Mr. Peter Keffer, of Reading, Pa.

The inventor says a pair of boots can be made after this manner in the time it takes to crimp the leather in the old way, and prevents the strain on the uppers to which crimping subjects them.

Mr. George Munro exhibited a specimen of a shoe made for a deformed foot, and illustrated the advantages of his mode of forming lasts from casts made from the foot.

BIBLIOGRAPHICAL NOTICE.

The Institutes of Medicine. By MARTYN PAINE, A. M., M. D., LL. D., Professor of the Institutes of Medicine and Materia Medica in the University of the City of New York, &c.: Fifth Edition—New York, Harper & Brothers.

The Institutes of Medicine treats of those broad principles of science concerned in the development, preservation, and perfection of the living organism. It includes more especially those particular branches of medical science known as physiology, pathology, hygiene, and therapeutics, and constitutes, in fact, the philosophy of medicine. Its object is to thus determine the laws of health and disease, and point out the means of preserving the former, and resolving as well as preventing the latter. In the work before us, an elaborate effort has been made to unfold these great principles of medical philosophy, yet, notwithstanding its author is one of the most erudite and accomplished medical writers of the day, the doctrines taught therein are now generally regarded as representing the knowledge of the past rather than of the present. Nevertheless, this work contains so much useful information upon the subject of which it treats as to render it very valuable, not only to physicians but to all others interested in medicine. Z.

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By JAMES A. KIRKPATRICK, A.M.

JULY.—The temperature of the month of July was a little more than one degree below the average for the last ten years, and a little less than one degree higher than that of July of last year. The warmest day was the 20th, of which the mean temperature was 87·7°, and the thermometer was highest on the same day, indicating a maximum temperature of 95½°. The coldest day was the 6th of the month, of which the mean temperature was 64·2°. The thermometer was lowest on the morning of the 7th, giving the minimum for the month 57°. The oscillations of temperature and the mean daily range of the thermometer were considerably greater than usual, though very nearly the same as for the month of July last year.

The pressure of the atmosphere was less than usual, the barometric column standing five-hundredths of an inch lower than the average of the month for ten years. The minimum (29·495 inches) occurred on the afternoon of the 5th, and the maximum (29·979 inches) on the morning of the 28th, showing for the whole month a range of less than half an inch. The only approach to a storm that happened during the month, occurred early on the morning of the 27th, and was very severe in the northern part of the city and the neighboring counties, where the lightning, which was very vivid, struck in several places. The wind was high, and the rain is said to have fallen in unusual quantities. In

the centre of the city less than two-tenths of an inch of rain fell on that morning.

The number of days on which rain fell was about the same as usual, but the quantity falling at each time was very small, in no case exceeding three-tenths of an inch. The quantity that fell during the whole month was less than seven-eighths of an inch, and less than has fallen during any July for the last ten years. The next lowest amount was in July, 1856, when an inch and one-eighth fell.

There was not one day of the month entirely clear, and but two days on which the sky was completely covered with clouds at the hours of observation.

The force of vapor and relative humidity for the month still continued considerably below the average, both for the last year and for the last ten years.

The atmosphere on the 18th was very favorable for observing the eclipse of the sun, which happened on the morning of that day. The following meteorological observations taken every ten minutes during its continuance may be useful for comparison.

Meteorological Observations during the Eclipse, July 18th, 1860, at Philadelphia.

	Thermometer.	Relative Humidity.	Force of Vapor.	Dew Point.	Barometer at 32° F.	Wind.	Clouds.		
							Sky covered.	Course.	Description.
	°	Per ct.	Inch.	°	Inch.	Direc.			
A. M., 6 h. 30 m.	72	62	·486	58·2	29·890	E N E	·3		Stratus, Haze.
40	73	58	·472	57·4	29·900	N E.	·3		" "
50	73	58	·472	57·4	29·920	N E.	·4		" "
7 h. 00 m.	74	59	·493	58·6	29·928	N E.	·4		" "
10	75½	56	·490	58·4	29·948	N E.	·4		" "
20	75	55	·479	57·8	29·948	N E.	·3		" "
30	75½	56	·490	58·4	29·938	N N E.	·3		" "
40	75½	57	·507	59·4	29·937	N E.	·3		" "
50	76	54	·483	58·0	29·937	N E.	·3		" "
8 h. 00 m.	76	56	·501	59·0	29·947	N E.	·3		" "
10	75½	57	·507	59·4	29·945	N E.	·2		Haze.
20	76	58	·518	60·0	29·945	N E.	·4		Cirrus, cir-st., Haze over Sun.
30	76½	58	·530	60·6	29·945	N E.	·4	N W.	" " Haze.
40	77	56	·523	60·3	29·945	N E.	·6	W N W	" " Cir-cu, Haze.
50	78½	55	·539	61·1	29·945	N E.	·6	N W.	" " Haze.
9 h. 00 m.	80	51	·518	60·0	29·945	N E.	·5	W N W	" " "
10	81	49	·523	60·2	29·954	N E.	·6	W N W	" " "
20	81½	50	·535	60·9	29·962	E N E.	·6	W N W	" " "

On the evening of the 20th, the warmest day of the month, about half past nine o'clock, a very extraordinary meteor appeared in the sky. It arose in the north-western part of the heavens, from a cloud which was made visible by the light of the meteor, from 25° to 30° above the horizon. Then an object, apparently about the size of the full moon, and as bright, suddenly starting from the cloud, traversed in an easterly direction the whole extent of the northern sky; sending off what appeared like sparks until it passed very far to the eastward, when it disappeared behind a cloud, at about the same distance from the horizon as that from which it started. The whole flight from west to east occupied a little less than a minute of time. Soon after leaving the edge of the cloud from which it started, it appeared to separate

into two parts of similar appearance, the smaller one closely following the larger and appearing as if connected with it by a band of light. Observers differ in regard to the height at which it passed the meridian, though the majority of those with whom I have conversed agree that it must have been at least 10° below the polar star. Its height at the meridian appeared to be very nearly the same as that at which it first appeared, giving the idea of a body moving in the direction of a tangent to the curvature of the earth's surface. It has been supposed from a comparison of observations made at many places, that the path of the meteor was vertical about 110 miles north of Philadelphia, passing over the northern part of Pennsylvania, in a nearly easterly course, over or near the north part of New Jersey, the south-west corner of the State of New York and Long Island Sound. If this supposition is correct, it must have been between 63 and 64 miles above the earth's surface in the meridian of Philadelphia. It pursued its course across the ocean, being seen many miles out at sea, and perhaps passed beyond the influence of the earth and resumed its original character of a wanderer in the planetary spaces. These are the results of our present information in regard to this stranger. Further and more accurate observations may somewhat modify the conclusions arrived at in regard to its precise position in our system.

A Comparison of some of the Meteorological Phenomena of July, 1860, *with those of July*, 1859, *and of the same month for ten years, at Philadelphia.*

	July, 1860.	July, 1859.	July, 10 years.
Thermometer.—Highest,	95½°	97°	100½°
" Lowest,	57	54	53
" Daily oscillation,	19·80	20·20	15·90
" Mean daily range,	5·00	4·60	3·80
" Means at 7 A. M.,	72·50	72·00	74·10
" " 2 P. M.,	83·89	82 68	83·93
" " 9 P. M.,	74·34	73·31	76·78
" " for the month,	76·91	76·00	78·27
Barometer.—Highest,	29·979 in.	30·212 in.	30·212 in.
" Lowest,	29·495	29·554	29·443
" Mean daily range,	·112	·099	·094
" Means at 7 A. M.,	29·811	29·870	29·861
" " 2 P. M.,	29 774	29·833	29 831
" " 9 P. M.,	29·787	29·853	29 846
" " for the month,	29·791	29·852	29·846
Force of Vapor.—Means at 7 A. M.,	·539 in.	·551 in.	·618 in.
" " " 2 P. M.,	·505	·574	·618
" " " 9 P. M.,	·559	·579	·645
Relative Humidity.—Means at 7 A. M.,	67 per ct.	69 per ct.	73 per ct.
" " " 2 P. M.,	43	51	53
" " " 9 P. M.,	65	69	70
Rain, amount in inches,	0·851	3·915	3·820
Number of days on which rain fell,	10	11	10
Prevailing winds,	s.70°1′w. ·135	s.84°6′w. ·166	s.64°17′w ·123

Abstract of Meteorological Observations for June, 1860; made in Philadelphia, Franklin, Indiana, and Armstrong Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

	Philadelphia.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. Kirkpatrick, Observer.								Chambersburg, Franklin Co. Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. Wm. Heyser, Jr., Obs.						Indiana, Indiana Co. 40° 40′ N. 79° 10′ W. Height, 1321 ft. W. B. Hildebrand, Obs.				Freeport, Armstrong Co. 40° 44′ N. 79° 42′ W. Height, 1000 feet. J. H. Baird, Obs.		
1860.	Barometer.		Thermometer.			Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Barom.	Thermom.		Force of vapor.	Relative humidity.	Rain.	Prevail'g winds.	Thermom.		Rain.	Prevail'g winds.	Thermometer.		Prevailing winds.
June.	Mean.	Mean daily range.	Mean.	Daily oscillation.	Mean daily range.	2 P.M.	2 P.M.			Mean.	Mean.	Mean daily range.	2 P.M.	2 P.M.			Mean.	Mean daily range.			Mean.	Mean daily range.	
	Inch.	Inch.	°	°	°	Inch.	Per ct.	Inches.	Direc.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.	°	°	Inch.	Direc.	°	°	Direc.
1	29·678	·055	67·3	12	5·0	·438	54		N W.	29·109	62·3	7·7	·389	63		S E.	55·3	12·3		N W.	54·0	10·7	(var.)
2	29·735	·063	70·7	21	4·0	·321	32		N W.	29·189	68·0	9·0	·336	37		W.	62·3	7·0		N W.	58·7	6·7	N W.
○ 3	29·691	·051	73·3	21	4·0	·375	37		S W.	29·101	65·7	2·3	·476	59	0·070	W.	59·0	6·7		(var.)	62·7	8·0	?
4	29·457	·234	69·0	16	4·3	·514	59	0·670	S E.	28·772	69·3	4·0	·524	51		W.	67·0	8·0	0·310	(var.)	69·0	7·0	S W.
5	29·287	·170	65·3	11	3·7	·576	84	0·100	S E.	28·648	68·9	4·3	·595	76	0·834	W.	63·0	4·7	0.160	S W.	60·7	8·3	N W.
6	29·469	·181	67·7	14	2·3	·520	66	1·460	W.	28·848	70·0	2·0	·505	56		W.	64·0	2·3	0.360	N W.	63·3	2·7	?
7	29·492	·025	71·0	17	3·3	·424	43		N W.	28·855	69·7	2·3	·489	62		W.	65·7	1·7	0.180	W.	65·7	2·3	W.
8	29·499	·032	68·7	19	2·3	·362	37	0·180	W.	28·861	68·3	3·3	·331	39	0·090	W.	58·7	9·0	0.760	N W.	57·0	8·7	W.
9	29·522	·039	63·8	13	4·8	·362	51		N W.	28·944	62·7	5·7	·502	79		W.	53·0	5·7		N W.	52·7	5·0	N W.
10	29·587	·065	66·0	19	2·5	·438	54		N W.	29·011	64·3	2·3	·358	46		W.	58·3	2·7		N.	57·7	5·0	(var.)
◐ 11	29·691	·104	69·0	21	5·0	·235	26		N W.	29·092	66·7	3·7	·305	34		W.	63·7	6·7		N W.	66·0	8·3	W.
12	29·807	·115	73·2	29	4·2	·294	28		N W.	29·167	71·3	4·7	·389	42		W.	71·3	9·0		N W.	70·0	6·7	E.
13	29·836	·037	74·7	25	2·2	·514	46		S W.	29·187	75·3	4·0	·382	37		W.	75·3	5·3		E.	70·0	0·7	S.
14	29·839	·042	75·5	24	0·8	·426	37		S W.	29·212	73·0	2·3	·501	51		E.	76·0	2·7		S E.	69·0	3·7	S.
15	29·835	·033	75·3	21	0·5	·440	39		S W.	29·204	73·3	0·3	·452	44	0·060	E.	74·3	1·7		S W.	72·3	3·3	W.
16	29·833	·008	70·3	17	5·0	·606	79	0·070	W.	29·207	66·3	8·3	·516	84		E.	68·3	6·0	0·380	N.	68·3	4·0	N.
17	29·874	·041	68·0	10	3·3	·562	79	0·325	(var.)	29·236	70·0	6·3	·614	68		E.	68·3	6·7		N.	66·0	2·3	E.
18	29·840	·039	70·7	18	5·0	·511	49		S E.	29·223	72·7	2·7	·524	51		E.	72·3	4·0		(var.)	70·7	4·7	?
● 19	29·641	·199	70·2	16	3·8	·611	68	0·570	S S W.	28·974	73·0	1·7	·497	45	0·045	W.	69·7	4·7		S W.	68·3	3·7	W.
20	29·596	·056	72·2	19	3·7	·525	52		N W.	28·978	70·7	4·3	·532	63	0·040	W.	66·7	3·7		W.	66·0	3·0	N.
21	29·828	·231	60·0	13	12·2	·383	66		N E.	29·186	65·0	5·7	·516	84		(var.)	68·3	1·7	0·160	N W.	63·7	2·3	N W.
22	29·929	·102	66·7	18	6·7	·321	41		N E.	29·316	64·3	2·7	·380	56		N E.	67·0	3·3		E.	60·7	3·7	E.
23	29·954	·025	71·8	25	5·2	·410	40		N E.	29·339	70·3	6·0	·470	52		N E.	68·7	6·3		E.	66·0	5·3	?
24	30·082	·127	70·3	21	1·5	·355	36		E N E.	29·473	72·7	3·0	·417	41		E.	74·7	6·0		E.	72·3	6·3	?
◑ 25	30·102	·040	71·8	25	2·2	·375	37		N N E.	29·514	70·0	2·7	·470	52		E.	74·7	0·7		S W.	73·0	2·0	N W.
26	29·978	·124	80·2	29	8·3	·494	35		W.	29·408	76·3	6·3	·650	54		(var.)	75·3	4·0		S W.	76·0	3·0	N W.
27	29·928	·050	80·7	15	7·2	·577	50		N W.	29·338	75·7	6·7	·827	86	0·220	(var.)	76·0	6·0		W.	72·3	5·7	W.
28	29·871	·057	80·5	20	5·8	·458	36		(var.)	29·256	79·3	3·7	·637	62		(var.)	76·7	4·7		(var.)	75·3	7·7	W.
29	29·650	·221	82·2	19	3·3	·717	48	0·331	W S W.	29·063	81·7	3·0	·809	59		(var.)	75·3	3·3	0·220	W.	78·0	6·0	S W.
30	29·683	·064	85·3	19	3·8	·776	53		W.	29·154	80·0	3·7	·802	71		S.	74·7	0·7		N W.	74·3	3·7	W.
Means	29·740	·088	71·7	19	4·2	·464	48	3·706	N 67° W.	29·104	70·5	4·2	·509	57	1·359	N 82° W.	68·1	4·9	2·530	N 55° W.	66·7	5·0	N 69° W.